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Proceedings of Workshop on

PRE- & POST-HARVEST VEGETABLE TECHNOLOGY IN ASIA

February 7-12, 1977

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TABLE OF CONTENTS

Foreword 3

Acknowledgement 4

The Need for a Tropical Vegetable Research and Development Network for Asia -- J.D. Drilon, Jr. and G. F. Saguiguit 5

Toward the Creation of the Tropical Vegetable Research and Development Network -- P.H. Calkins 9

Research in Vegetable Production Technology -- Hansani Pekerti and Masman Bekti 15

Vegetable Production in a Development Context -- Somporn Drabyasara and Anothai Choomsai 30

Cropping Systems Including Vegetables -- Pritana Pradipasen 39

Marketing Vegetables in the Philippines -- Enriquetta B. Torres 48

Conventional and Non-conventional Vegetable Processing in Taiwan -- Chin Fung Li 60

Vegetable Production in Sri Lanka -- Y.D.A. Senanayake 70

The Vegetable Production and Marketing in the Himalayan Kingdom of Nepal -- Dhruba Raj Pandey..... 85

The Status of Vegetable Production and Marketing in Bangladesh -- Abdur Razzaque 96

Vegetable Growing in Thailand -- Banchong Sikkhamondhol 101

Vegetable Production and Marketing in the Philippines -- Domingo F. Panganiban 111

Vegetable Production and Marketing in Korea -- Chung-Il Choi 118

Gaps in Research Knowledge and Capabilities, South Asia 128

Gaps in Research Knowledge and Capabilities, East Asia 131

A Critical Analysis and Overview of the Vegetable Industry in Asia -- James C. Moomaw 133

A Proposal for Integrated Surveys of the Present and Future Role of the Vegetable Industry in Nine Asian Countries -- Peter H. Calkins 141

FOREWORD

Between February 7 and 12, 1977, an International Workshop on Pre- and Post-harvest Vegetable Technology was held under the joint auspices of the Asian Vegetable Research and Development Center, Tainan, Taiwan, and the Southeast Asian Regional Center for Agriculture , Los Baños, Philippines. The Workshop was further supported by the Asia Foundation and the Ford Foundation. Governmental and scientific participants from Bangladesh, Nepal, Sri Lanka, Thailand, Indonesia, the Philippines, the Republic of China, the Republic of Korea, Japan, and the United States were in attendance.

Through resource and country-background papers, major technical problems and the existing state of the vegetable industry in each country were described and discussed. The participants and sponsors found the results of these discussions fruitful and agreed to publish the proceedings.

This publication contains the papers presented and partial transcripts of the discussion periods. It is being published in the belief that such information will serve as a first step in achieving purposeful integration of the vegetable industry in Asia and the betterment of the lifestyles of its people.

The workshop participants accomplished the following further objectives:

1. Agreed that since the terms "pre-harvest" and "post-harvest" can easily be further divided into the six categories, pre-production, production, post-harvest handling, processing, marketing, and consumption, an integrated survey approach is needed to promote vegetable development in the tropics.

2. Agreed on the types of information that should be available for international and national research organizations in the participating countries to better design and implement their programs of vegetable research and extension.

3. Collected and compared information on vegetable research already conducted in participating countries.

4. Identified and ranked the problems facing vegetable development in the participating countries and the crops which should receive special emphasis.

5. Developed a format for collecting basic background information on the agro-climati environment, cultural practices, and manpower and institutional ca ities.

6. Revised survey forms relating to production and marketing, and affirmed the need for similar forms relating to processing and consumption.

7. Determined the number of interviews to be completed for each of these four types of surveys in the total survey plan.

8. Agreed on an overall survey design, including the personnel, supporting facilities, and length of time necessary.

9. Reported estimates by country of the cost of each component of the integrated survey.

10. Formally entrusted the final preparation of the "Joint Proposal for an Integrated Survey of the Potential for Vegetable Development" to the Asian Vegetable Research and Development Center.

A summary of the final proposal begins on page 141 of this publication.

ACKNOWLEDGEMENT

Four organizations sponsored the Workshop on Pre- and Post-harvest Vegetable Technology in Los Baños, the Philippines, February 7 through 12, 1977.

The Asia Foundation made possible the travel of many of the international representatives to the Philippines and aided in financing this publication of the proceedings.

The Ford Foundation sponsored one participant and was committed to supporting two more if there had been time to arrange for their attendance.

The Southeast Asian Regional Center for Agriculture (SEARCA) and the Asian Vegetable Research and Development Center (AVRDC) jointly shared the remaining costs. Special tribute is due to the administrative and clerical staff at SEARCA.

The directors of both SEARCA and AVRDC took time to write papers for presentation at the conference. The involvement of Drs. J.D. Drilon and Gil F. Saguiguit of SEARCA and James C. Moomaw of AVRDC strongly emphasized the commitment of these two institutions to the promotion of the vegetable industry in Asia and the tropics.

Special acknowledgement is also due to Mrs. Carmen Necessito, who transcribed the discussion periods of the Workshop and performed the initial editing of the contents of this volume.

The greatest contributors, of course, were the participants of the Workshop themselves, whose ideas and aspirations unfold in the following pages.

THE NEED FOR A TROPICAL VEGETABLE RESEARCH AND DEVELOPMENT NETWORK FOR ASIA

J.D. Drilon, Jr. and G.F. Saguiguit[+]

We are gathered here today with great hopes for increasingly auspicious and effective efforts in vegetable research and development in Asia. Although we are only a handful of scientists and other workers coming from selected countries and institutions interested in vegetables as a source of human nutrients, our contributions this week may well result in the involvement of millions of people in the improvement and utilization of vegetables, which we all know are vital and economic sources of plant protein, vitamins, and minerals.

Malnutrition, besides hunger, is a scourge mankind must battle today.

On a global basis, human suffering from hunger and malnutrition is partly measured by statistics. It has been reported that about one billion people are adversely affected by this twin problem, that about 10 million children - a most vulnerable group - are so seriously afflicted by malnutrition, that their lives are actually threatened, that about 400 million people are on the brink of starvation, and that approximately 12,000 people perish from hunger each day.

Hunger and malnutrition are the greatest threat in Asia, when one compares this region with those of other parts of the world. In India alone, about one million children die of malnutrition every year. In the Asian subcontinent, India, Bangladesh, and Sri Lanka are the most severely affected areas and grain shortages alone during a bad year reach beyond six million tons. Most of the rest of Asia has also been identified as a potential problem area.

This information highlights the importance of considering the adequacy of food not only in terms of quantitative sufficiency but also in qualitative value. It is not enough to provide people with sufficient supply of staple food items which are principal sources of carbohydrates. It is imperative that enough of the protective foods which are sources of protein, vitamins, and minerals are also made readily available to them.

Unfortunately, in many parts of Asia, there is a predominant tendency to rely heavily upon sufficiency in staple food crops alone. National efforts are often biased in favor of devoting resources to the development of these crops. Given limited resources in most Asian countries, this bias does seem realistic but it carries the danger of promoting and perpetuating a lopsided propensity which, by inertia, makes it difficult for nations to adopt programs that would ensure sufficiency in protective foods.

It has been said that the problem of food insufficiency has been aggravated by poverty, which in itself is a factor limiting food intake.

[+]Dr. J.D. Drilon, Jr. and Dr. G.F. Saguiguit are Director and Assistant Director, respectively of the Southeast Asian Regional Center for Agriculture (SEARCA).

Thus, hunger and malnutrition on the one hand and poverty on the other reinforce each other in a cyclical fashion to suppress and keep the well being of mankind at low levels. The solution to poverty is sometimes simplified to a prescription of higher incomes which should be generated through higher farm productivity and/or more off-farm employment.

Better vegetable technology offers something in this regard. It offers to farmers the possibility of increasing their incomes through multiple crop patterns involving the use of vegetables as suitable supplementary crops or, in certain cases, even as substitute crops.

At the Asian Vegetable Research and Development Center, excellent work is now being pursued toward the development of vegetable technology covering six crops, namely, mungbean, soybean, tomato, Chinese cabbage, white potato and sweet potato. Well-equipped and manned by a young, vigorous group of scientists, this Center is likely to make breakthroughs and advances in the near future.

In other parts of world, competent research work on vegetables is also going on. The International Center for Tropical Agriculture (CIAT) in Colombia is working on field beans and other lequmes, in addition to other crops. The International Potato Center in Peru is concentrating on white potato. The International Institute for Tropical Agriculture (IITA) in Nigeria has programs on cowpea, soybean, lima bean, pigeon pea and sweet potato. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in India includes pigeon pea and chick pea in its programs.

These complementary efforts in various parts of the world are aimed at bridging the knowledge gap in vegetables between existing traditional systems and those capable of eliminating the limiting factors associated with such systems. New varieties of vegetables and the new cultural practices they will require are likely to emerge. It is only a matter of time before these research centers, well endowed as they are in terms of scientists, facilities, and support from the international community, produce such new technologies.

But these new technologies, to be of real value, must be translated into action programs that are able to reach people, whether they are producers or consumers or other entities that service the requirements of these principal participants in the production and marketing units of commodity systems.

This suggests the need to see to it that a complete chain of efforts is assured and that institutions assigned the generation of knowledge through agricultural research be complemented by mechanisms that will package and transfer newly found, productive technologies, efficiently and effectively.

In developing countries, this is more easily said than done. Constrained by limited resources and restrained by underdeveloped manpower, some of them - left on their own - are unable even to see the possibility of moving their agricultural economies to higher plateaus.

This is where international collaboration can be a great boon!

In vegetable research and development in Asia, we foresee the possibility of nations being able to develop a network that will, on a

mutually beneficial basis, hasten tropical vegetable research and development in this part of the world.

Such a network could be based in a center, preferably with an accepted geopolitical framework that enables countries to work on projects and programs more through scientific and economic considerations of mutual interest rather than through any other consideration, particularly if it is self-centered and self-protective.

Of course, the Center should be geographically located within tropical Asia so that research work conducted in the country of its location would have greater relevance and applicability to this part of the region. A strong national vegetable program and an auspicious scientific community in the Center's country-location would be of great value. A stable government would be essential.

Unlike most international research organizations, the tropical vegetable research and development network will not require high-cost infrastructure at the Center. Research work requiring sophisticated equipment could be done in established, well equipped institutes such as the Asian Vegetable Research and Development Center itself, or farmed out to other institutions, existing or yet to be established.

The network could be managed by a modest staff to be located at the Center which will be directly advised by an intermediate policy board to be composed of outstanding individuals who can influence the conduct of vegetable research and development programs in their respective countries. The Center, with its own corporate governing body, will play the role of a facilitator.

The components of the network will be the national vegetable programs or projects of participating countries themselves. Under this concept, the national governments concerned are expected to shoulder most of their program costs as they would be clearly aware that their financial contributions would directly benefit their respective countries. External support would then be devoted to coordinative work at the Center and to "seed" assistance for the country programs, particularly during the first 3 to 5 years of the network's operation.

Assistance, usually provided through bilateral agreements, could be enhanced and obtained through the joint efforts of country programs and the Center.

We believe that the mutual stimulation and support that are likely to be generated by this collaborative effort, will considerably increase the metabolic rate of action in the development of vegetable industries in tropical Asia.

As you go through this workshop, it is our hope that you will keep this suggestion in mind, to see whether your output will confirm or deny its wisdom or its folly.

In closing, allow us to express the hope that this workshop under the sponsorship of SEARCA-UPLB and AVRDC with additional financial support from the Asia Foundation and the Ford Foundation, will turn out to be as productive as you could wish to make it.

TOWARD THE CREATION OF THE TROPICAL VEGETABLE RESEARCH AND DEVELOPMENT NETWORK

Peter H. Calkins[+]

At present, research on vegetable crops[++] has a low priority in most Asian countries. The funds and personnel assigned to vegetable crops research are a fraction of those assigned to rice and other cereal crops. While the importance of vegetable crops to multiple cropping systems is receiving increasing attention in rice research programs, this new thrust has not significantly benefitted the national vegetable crops research programs.

The few programs for the development of vegetable production and marketing which do exist aim to provide increased income to the producer, wider seasonal variety of vegetables at a lower price to the consumer, and improvement in the nutritional status of both rural and urban populations. However, funds are not usually available in programs to sponsor the travel of scientists conducting vegetable research. Thus, there has been all too little interchange of ideas or technology among these Asian researchers. Moreover, the contribution of vegetable crops to the national economy is not generally visible in production indicators used for cereal crops. This phenomenon is partially the result of the small plots on which most vegetable crops are grown and tends to reinforce the low priority assigned to vegetable crops research in national programs.

Enormous Potential in Vegetable Crops

Yet vegetable crop production and marketing have enormous potential for increasing individual and national well-being. Many vegetable commodities, such as the green leafy and fruit types, have high income and price elasticities of demand. As national incomes rise and improvements in the efficiency of production and marketing of these products contribute to price reduction; producers, consumers, and marketing agents all stand to gain. Root crop vegetables, on the other hand, are often staple commodities which, with improvements in per hectare yields, could offer a sufficient supply of carbohydrates to the urban and rural poor and give competitive levels of overall income to producers.

Similarly, if improvements in the production and processing technology of legume vegetables can be developed, these crops will offer an efficient means for narrowing the protein gap. At the same time, the green leafy and fruit vegetables are rich in vitamins and minerals; and the availability of root crops both supplements grain consumption and provides a better amino acid balance in the diet. Indeed, now that large areas have already been covered by the new high-yielding varieties of cereal crops, improved vegetable production technology offers the next major frontier for correcting the imbalance between food and population.

[+]Dr. Peter H. Calkins is Associate Agricultural Economist at the Asian Vegetable Research and Development Center and Coordinator for the Workshop on Pre- and Post-harvest Vegetable Technology.

[++]Defined to include the leafy, legume, root, fruit, and flower types.

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Fortunately, interest is growing in stimulating greater production and consumption of vegetable commodities throughout Asia. The Technical Advisory Committee (TAC) of the Consultative Group on International Agricultural Research (CGIAR) has made efforts to establish a multinational Vegetable Research Project in the tropics. The Southeast Asian Regional Center for Agriculture (SEARCA) has recently distributed a proposal for a Regional Coordination Center for Tropical Vegetable Research and Development. The International Development Research Center (IDRC) is funding programs in post-harvest vegetable physiology. And the nations of Asia, through both their national programs and participation in international conferences, continue to strive for improvements in farmer income and consumer diet through the development of the vegetable industry.

All these efforts are compatible and have a potential impact far greater than that of the sum of their parts. Yet to realize their potential, such efforts must be integrated on the basis of an overall strategy for vegetable development in Asia.

Without a workshop of the present kind it is doubtful that true integration of the scarce manpower and capital resources available for vegetable research in the tropics can be achieved. Nor is there much hope of expanding these resources without the purposeful meeting of many nations to identify common problem areas. Figure 1 on the following page outlines a step-by-step procedure for developing a network of national and international programs for vegetable improvement. In Stage I, the present workshop, it will be necessary to inventory current pre- and post-harvest vegetable crop technology and approaches to its development in the participating countries. It may become clear that there are gaps in existing knowledge, that there are duplications of effort from one country to another, and/or that the original assumptions and approaches underlying horticultural research and development in the participating countries have been eclipsed by other more urgent problems.

The specific objectives of this Workshop on the Pre- and Post-Harvest Technology of Vegetables are to:

1) Determine what information should be available for international and national research organizations in participating countries in order to better design and implement their programs of vegetable research and extension.

2) Review programs to date and collect and compare information from vegetable research already conducted in the participating countries.

3) Determine, from 1 and 2, gaps and needed changes in the approach for the development of production and marketing of vegetable products.

4) Agree on a similar format and division of responsibility so that experiments and surveys conducted in these countries can fill gaps in current information quickly and efficiently.

5) Draft and approve an estimated project budget and proposal for submission to funding organizations.

6) Determine how the final results of the surveys should be used to create a vegetable development network in Asia and the tropics.

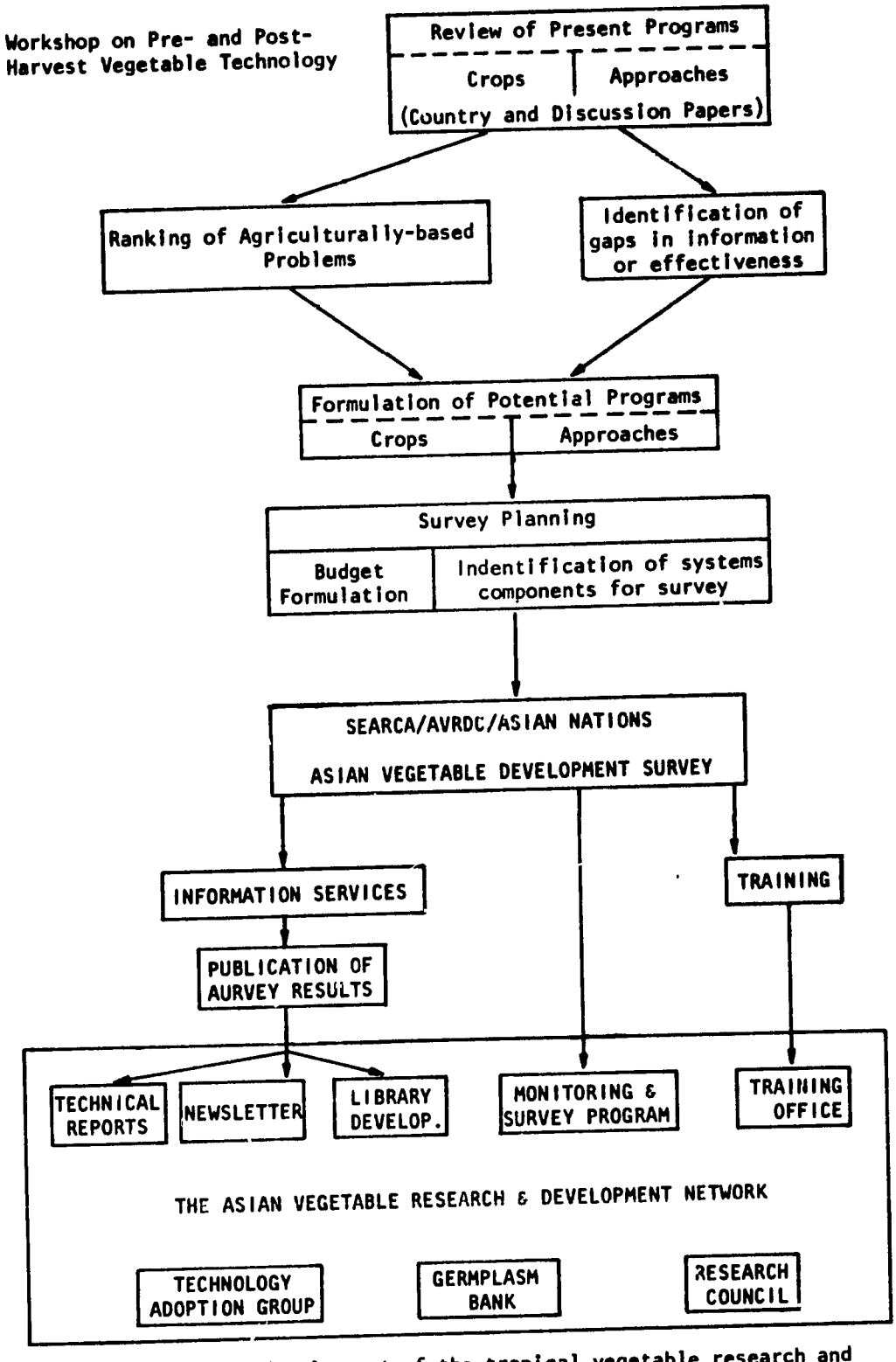

Fig. 1. Stages of development of the tropical vegetable research and development network.

If the proposal is approved, we will proceed to Stage II, the Asian Vegetable Development Survey. This Survey might be concurrently conducted under outside funding for about 18 months beginning in late 1977. Results can be collected and analyzed over this period and the final report prepared for distribution by the end of 1979.

Such a report will do much to make international, governmental, private, and educational organizations aware of the needs of vegetable producers and consumers in Asia. It will help both to reorient programs and to attract funding for them. By systematically treating the production, environment, management, marketing, consumption, and nutritional patterns in tropical countries, it will clarify for national and international institutions the priorities and components to be built into an Asian Vegetable Research and Development Network (Stage III).

The components of the Network will include information services such as the development of libraries, Network Technical Reports, and a regular Network Newsletter; exchange of personnel and germplasm; coordinated information gathering through experiments and surveys; and the development of a monitoring system for input and output prices, weather conditions, and other information. (Fig. 2).

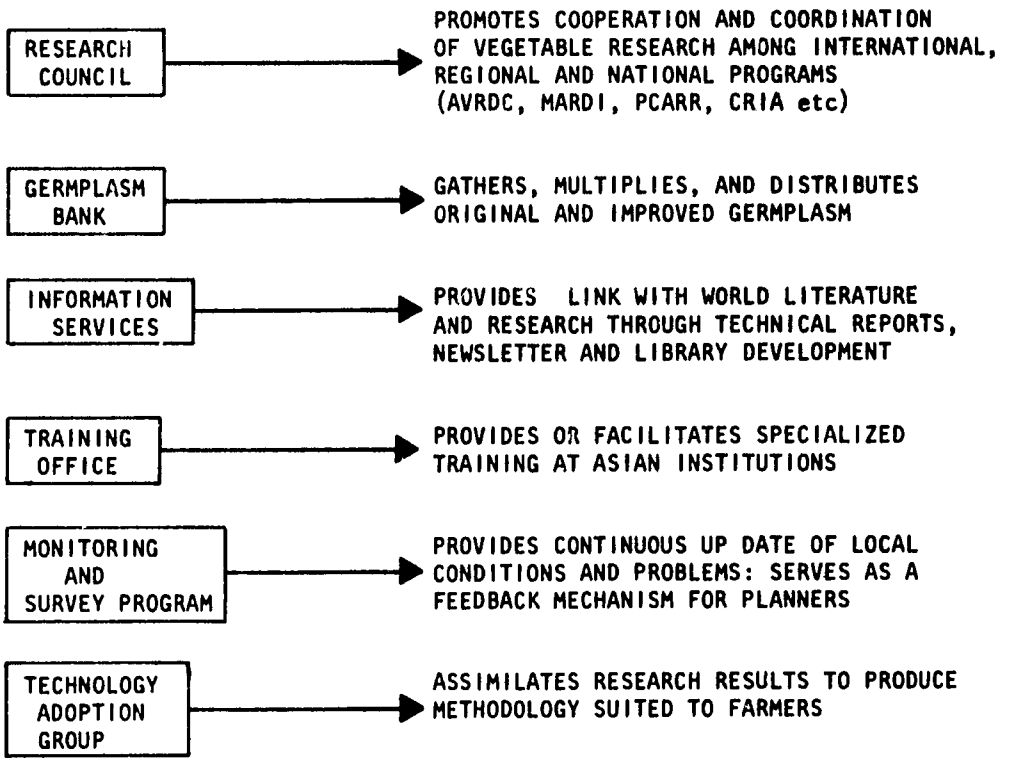

Fig. 2. Coordinating components of the Asian vegetable research and development network.

Thus, the present Workshop is not an end in itself, but the potential beginning of increased collaboration and exchange among physical and social scientists working for the development of the vegetable industry in Asia.

An Appropriate Framework for the Workshop

In working to meet the six objectives of Stage I, it will be necessary at all times to think in terms of specifics, and to what extent specific pieces of information may be acceptably generalized. Thus, the key to success will be problem-oriented research and well defined programs. We must first decide the major problems to be addressed and the crops which can best solve those problems.

Having identified the crops, we should specify agro-climatic zones and seasons in which they can best be produced to meet the objectives. Only then may development priorities for breeding lines, cultural practices, insect and disease resistance, physiology, post-harvest handling, credit, marketing and international trade be adequately identified. For example, there is great geographical diversity and seasonality in the quality of roads and the availability of production capital to low income farmers. The life cycles and population dynamics of insects also follow distinct patterns. Diseases attack in certain seasons, and more so in certain cropping regimes than others. In all cases, we will try to identify similar regions in terms of climate and other indices, but we must begin with as specific information as possible. In this way, the technologies to be developed will be most applicable to the farmers and processors who will ultimately stand to adopt them.

Second, we should formulate and bear in mind a set of short-term, medium-term and long-term goals for the Asian Vegetable Survey and Network (Stages II & III). An illustrative but tentative list of these goals might be as follows:

Goals for Asian Vegetable Survey and Network

Short-term:

1) Determine the quantitative and qualitative need for specific vegetables.

2) Develop suitable breeding lines and physiological types to meet these needs.

3) Tailor crop management and other pre-harvest technology to optimize economic return, and not necessarily maximize agronomic yield.

4) Provide for seed multiplication of promising cultivars.

5) Monitor through national programs the performance of improved vegetable crops and technology in major cropping systems.

6) Organize inter-country research experiments for pre-harvest technology.

7) Measure the loss in quality and marketable quantity of vegetables during post-harvest handling and storage.

8) Develop technologies to reduce those losses, if economically feasible.

9) Establish training programs for researchers and extension leaders for both pre- and post-harvest technology.

10) Monitor disease, insects, weather, and prices.

11) Begin to develop a Newsletter and Technical Bulletins for exchange of information even before the Tropical Vegetable Survey is completed.

12) Investigate plans for trade unions and other special trade agreements among participating countries to reduce vegetable prices and increase seasonal and varietal availability.

13) Organize regional field days to visit national and international research centers.

Medium-term:

1) Close the gap between basic and applied research.

2) Accelerate the transfer of research materials and experience and the verification of their effectiveness.

3) Develop leadership and competence to identify and solve major vegetable related problems as they develop.

Long-term:

1) Increase national yields and on-farm profitability of selected vegetables in countries of the tropics.

2) Provide more abundant sources of protein, carbohydrates, vitamins, and minerals to rural and urban consumers in the tropics.

3) Promote employment opportunities through increased cropping intensities on the farm and vegetable processing off the farm.

4) Promote specialization and trade among regions to further increase vegetable availability and improve the balance of payments for countries in the tropics.

This list is subject to considerable amendment, but we should bear the above and other potential issues constantly in mind as we assess our current information needs.

RESEARCH IN VEGETABLE PRODUCTION TECHNOLOGY

Hansani Pekerti and Masman Bekti[+]

Vegetables are not only rich sources of the vitamins, minerals, and plant protein necessary to maintain a balanced diet, but also add flavor to man's diet and help us keep our figures slender and healthy. In many Asian countries, vegetable production is inadequate to meet nutritional requirements on a year-round basis. Among low income groups of both rural and urban populations, specific vitamin and mineral deficiencies are evident.

Vegetable culture, being generally labor intensive and having a short time from planting to harvest, is suitable for increasing the income of the small farmer in Asia and provides one of the most important methods of increasing the amount of food on a per hectare basis. Farmers who cultivate with smaller acreages have learned that one can earn more growing horticultural crops than growing cereal crops. Vegetable production also makes more effective use of land and labor resources for agricultural development.

In spite of the economic advantage of horticultural crops, research efforts in agriculture have been mainly directed at increasing staple food production like rice and wheat; much less attention has been paid to vegetable crops. This situation should be changed and more attention given to vegetable crops backed by more intensive research work aimed at increased production improvement of the quality of vegetables.

FACTORS IN VEGETABLE RESEARCH

The vegetable research and development programs in many countries are generally aimed at production increase and quality improvement to meet the nutritional requirements of the population and increase the income of the farmer. To give full support to the program a number of activities covering three major areas of interest should be given special attention, namely, vegetable research, production and marketing. Research in the technology of vegetable production conducted in Asian countries covers some or all of the following research disciplines.

a. Varietal improvement.

b. Seed production technology.

c. Culture and management.

d. Crop protection.

e. Post-harvest physiology and handling.

f. Processing.

g. Marketing.

[+]Mr. Masman Bekti and Mr. Hansani Pekerti are Director and Research Scientist, respecitvely, of the Horticultural Research Institute, Jakarta, Indonesia.

To obtain satisfactory results in research, four essential factors are required, viz., management, man, money, and material, known collectively as the 4 Ms.

Management

The central research station located in Pasarminggu, Jakarta has substations in West Java, East Java, and North Sumatra. The HRI has approximately 204 ha. of experimental fields. At present, laboratories are available for research in plant breeding, agronomy, crop protection, and food technology.

The director and heads of the divisions are assisted by about 80 researchers, and an equal number of research assistants are assigned to carry out the national horticultural research program. The main difficulties confronting the program are research coordination, lack of experienced senior researchers, inadequate laboratory facilities, and the very limited availability of funds.

In a recent technical meeting on horticultural research (23-25 March 1976) vegetable research priorities covering a wide range of disciplines were identified (Table 1).

Research Manpower

Vegetable research in Indonesia was initiated later than programs for the staple food and estate crops. The departments or divisions of horticulture in most universities were established only in the last decade. This situation is reflected in the present state of research manpower in horticulture, which is mainly composed of a few experienced researchers and many young graduates and junior researchers.

The present distribution of researchers and technical personnel at the Indonesian Horticultural Research Institute is presented in Table 2.

About 50% of the staff is engaged in vegetable crops, 30% in fruit crops, and 20% in ornamental plant research. Some of them have trained in short-term courses in the Netherlands, Japan, and India. Two staff are in Ph.D. plant breeding programs.

The education and training of research manpower should be given priority. This applies not only for Indonesia, but also for many other Asian countries. The success of a research program depends to a large extent on the availability of trained manpower. At present more researchers of high quality are needed, who in turn could pass their knowledge and experience to younger researchers.

Another point worth considering is the training of extension workers in horticulture. Because of the intensive nature of vegetable culture and the relatively long experience of vegetable farmers; the training courses should be of longer duration, more intensive, and specifically adjusted to regional needs.

Funding

Funds, as cited before, are relatively limited for horticultural research compared to other crops. One way of over-coming this constraint is for researchers in various research disciplines within the institute

Table 1. Summary of research problems related to their attainment in Indonesia.

Problems	Research areas
Varietal improvement	Genetics Plant introduction Hybridization and selection Seed improvement Local adaptability
Ecological factors	Soil fertility and fertilizer application Cultural technique Water management Cropping system
Crop protection	Biology and ecology of pests Mycology Entomology Nematology Bacteriology Virology Weed control
Production utilization and protection	Pre- and post-harvest physiology Handling, transportation, and storage Processing Standardization and quality control
Production efficiency and marketing	Farm management Cost and return analysis Marketing/market analysis

Table 2. Distribution of researchers and technical personnel at the Indonesian Horticultural Research Institute.

Highest degree attained	Location					Total
	Jakarta Cipanas Segunung	Lembang (W.Java)	Yogya (C.Java)	Malang (E.Java)	Gurgur (N.Sumatra)	
Ph.D.		1[a]				1
M.Sc.	30	12		6	1	49
B.Sc.	18	6	3	13		40
Secondary vocational/school	35	14		18	11	78
Total	83	33	3	37	12	168

[a]One Ph.D. as a consultant.

to cooperate closely with other related national and international agencies. For instance, test trials of certain tomato lines received from AVRDC in the Indonesian lowlands showed high resistance against bacterial wilt and produced higher yields than local checks. We plan to conduct trials to assess production costs and returns of the selected tomato lines and use such lines in post-harvest experiments such as handling, transportation, storage quality, and processing.

Since 1970, scientists from Indonesia and the Netherlands have engaged in cooperative horticultural research, particularly on highland vegetables. The World Bank and IBRD will also support vegetable production in Indonesia. Research laboratories will be established in Lembang, West Java. Technical assistance and training of research personnel also are included in this project.

Laboratory Facilities

Vegetable research should be pursued with well-equipped laboratories, libraries, and other facilities. Fertilizer application trials without the support of soil and plant analysis; breeding experiments of nutritional quality without laboratory analysis will give less than adequate results.

At present, HRI has fairly well equipped laboratories for crop protection and food technology studies. For certain analyses, samples have to be sent to other institutes or agencies. With the ever-increasing number of experiments using statistical experimental designs, more modern instruments are required to conduct a large volume of physical and chemical analyses within a certain period.

Research Progress in Vegetable Production Centers

Plant Breeding

The important activities of vegetable breeding include germplasm collection, testing, hybridization and selection, adaptation, and seed improvement. The vegetable crops to be improved by plant breeding research in HRI include white cabbage, white potato, tomato, Chinese cabbage, shallot, chili pepper, and cauliflower.

The research on vegetable production in Indonesia has concentrated mostly on introduction of varieties from abroad and selection for overall performance, including general resistance against major diseases and high yield potential. Cultivars with fair resistance against major diseases such as *Phytophthora infestans* and *Pseudomonas solanacearum* have been developed on several occasions.

The breeders succeeded in inducing flowering and seed formation in Chinese cabbage and cauliflower to enable local seed production.

Agronomy

Soil fertility, water management, and other cultural practices are factors that influence the yield of vegetable crops. Activities to date have included fertilization experiments to determine the optimum NPK requirement of selected vegetable crops such as white potato, tomato, white cabbage, cauliflower, Chinese cabbage, and beans. Other studies deal with the improvement of nursery culture, method and time of transplanting,

optimum plant population density, and optimum water requirements of these vegetable crops.

The application of large amounts of stable manure to increase the yield of vegetable crops has long been practiced by farmers. The high demand for stable manure in the vegetable production areas has led to scarci · of supply and high prices. Thus, experiments have been conducted to reduce or substitute the use of stable manure using green manure and commercial organic fertilizers.

Multiple cropping has also been practiced by Indonesian farmers for a long time. This cropping system is necessary due to the small area of land owned by the average farmer, who tries to get the most out of it. Experiments to improve existing multiple cropping systems have been conducted with the aim of increasing earnings per unit area and time and the creation of more labor opportunities to reduce unemployment.

Crop Protection

The climate in the tropics is favorable for the buildup of pests and diseases, which often cause heavy losses to vegetable crops. Crop protection, therefore, has an important role in preventing and reducing these losses.

Surveys and experiments showed that yield reductions of highland vegetable crops in Indonesia due to pests and diseases ranges between 15 to 90% as shown in Table 3.

Table 3. Percentage of crop losses of highland vegetables due to pests and diseases in Indonesia.

Crop losses (%)	Crop	Cause of damage	Remarks
46-90	Cabbage, tomato, potato	Insect pests	
50	Tomato, potato	Leaf spot and wilt	
20-30	Tomato, potato	Bacterial wilt	
15-30	Potato	Nematodes	Affects quality
70	Potato	Nematodes	Affects quality

No data, however, are available on losses caused by pests and diseases for garlic, shallot, chili pepper, and other priority crops. Farmers occasionally report losses of these vegetable crops due to pests and diseases. The principles of pest management have been applied to prevent losses of vegetable crops caused by pests and disease.

Research activities in vegetable crop protection to date are:

I. Survey and Identification.

Surveys were conducted to identify pests and diseases in the vegetable production areas on the islands of Java, Bali, Sumatra, and Sulawesi. A differential incidence of major pests and diseases was observed in the centers where the survey was conducted.

II. Biology and Ecology.

The study of the biology and ecology of major pests and diseases and their parasites and predators are necessary to develop effective control methods.

The life cycles of *Heliothis armigera Hbn.* (tomato) and *Agrotis ipsilon* (cabbage) has been studied. The white potato cultivar Eigenheimer showed symptoms of mosaic, rugosity, and vein necrosis caused by PVY and PVX virus. Leaf-eating insects of the Family *Noctuidae (Plusia* sp., *Heliothis* sp., *Spodoptera* sp.*)* may affect the development of potato tubers and reduce the yield. Covering the tubers of potato crops in the field with soil is an effective method to control *Phythorimaea.* Twenty host plants were infected by *Meloidogyne incognita.*

III. Varietal Test for Resistance

Varieties of important vegetable crops were tested and selected for resistance against major plant diseases such as bacterial wilt, *Fusarium, Phytophthora infestans,* viruses, and nematodes. Tests have been conducted in both laboratory and field for resistance.

Vegetable cultivars which have some resistance to the different diseases and pest are:

Potato	Rapan 104, No. 6-52-9, Rapan 181	*Meloidogyne* sp.
Tomato	Nemared, Anahum Isabella, Ganefo MM Nova NVFC	*Meloidogyne* sp.
	AVRDC Acc. 22, Bonzet (new)	Late blight
	AVRDC Acc. 33, 22, 15	Bacterial wilt
Cabbage	KK cross, Titan-90, NS cross	*Meloidogyne* sp.
	KY cross, KK cross	*Plutella xylostella, Crocidolomia binotalis*
Chinese cabbage	Granat	*Meloidogyne* sp.
Cauliflower	Primura	*Meloidogyne* sp.

IV. Efficacy of Pesticide Application.

Current crop protection practices in Indonesian vegetable culture vary in accordance with the different categories of cultural activities.

Fungicides and pesticides are most commonly used by commercial vegetable producers. Excessive and inadvertent use of these commodities may endanger man and his environment. We have conducted research on the efficacy of pesticides, which are effective, need minimal quantity of application, and are selective (small spectrum), cheap, and relatively safe to man.

The following insecticides and fungicides are effective for the protection of potato, tomato, and cabbage.

Crop	Pest/disease	Pesticide/fungicide and dosage
Potato	*Phthorimaea*	Orthene 75% EC
	P. infestans	Difolatan 4D 0.25%, 3-day interval
Tomato	*Heliothis*	Dipel 0.50%-0.20%
	Meloidogyne sp.	Aldicarb 7.5 kg/ha DDT-mixture 200 lt/ha
	P. infestans	Difolatan 4F 0.30%, 3-day interval
Cabbage	*Plutella*, *Crocidolomia*	Vondozeb 0.20%, 3-day interval Hostathion 40 EC 0.10% 80 lt/ha

V. Cultural Practices.

Experiments in cultural practices to prevent or suppress the development of certain pathogens and pests and to keep them from reducing yields are still in progress.

VI. Vegetable Product Technology

Generally, vegetables are known as a group of agricultural produce having a short storage life. They are more perishable compared to the cereals. Vegetable product technology is designed to extend the storage life of vegetables in both fresh and processed states. Research has been conducted in this field, which covers the following phases or research disciplines.

VII. Pre- and Post-harvest Physiology.

In growing vegetable crops, much capital investment, effort, and time are spent before the crop is harvested. The time of harvest, although relatively short, is a critical moment which affects the quantity and quality of the harvested produce. For example, when snapbean or cabbage are picked too early, the total yield is lower than it should be. On the other hand, when picked too late, snapbean becomes too fibrous and cabbage may burst, a condition which impairs the quality and decreases the price.

To determine the optimum harvest time of vegetable crops, research in pre- and post-harvest physiology of these crops is needed. The optimum picking maturities of 8 tomato cultivars, 2 snapbean cultivars, and 2 kidney bean cultivars have been determined.

VIII. Fresh Handling.

It is estimated, that the harvest-to-consumer-waste of vegetable produce due to damage and spoilage is about 30%. To reduce waste, research in fresh handling of vegetable crops has been conducted through trials on the handling, grading, packaging, transporting, and storing of tomato, cabbage, and cauliflower.

IX. Processing.

Seasonal overproduction of vegetables such as cabbage, shallot and chili pepper occurs frequently. The prices of those commodities often drop below production costs. These commodities also have a short storage life. Processing the surplus produce might help stabilize prices and extend storage life. Moreover, development and establishment of new vegetable processing industries would create new job opportunities and help to reduce unemployment.

Experimental work has been done in the processing of vegetable products. Vegetables are processed into various products as follows:

Tomato	Catsup, juice, wine, and waste products processed into animal feed.
White cabbage	Sauerkraut.
Shallot, cucumber	Pickles.
Potato	Dried potato chips.
Red chili pepper	Dried whole fruit and powder.
Mushroom	Canned products.

X. Experimental Cookery.

The area of experimental cookery deals with testing of the cooking quality of selected vegetable varieties, preparation of new recipes as well as improving and maintaining the nutritional quality of prepared food. These activities might be potential channels of promoting and popularizing vegetable food consumption by means of leaflets, publications, short courses, and demonstrations to teachers, women organizations, and similar groups.

XI. Standardization and Quality Control.

Standardization and quality control are important measures in food production and processing to regulate the trade of vegetable products and safeguard the interests of the consumer. Standardization and quality control measures include food analysis, food microbiology and sensory evaluation, and supportive research work conducted in the other areas of research. Standards for fresh commercial vegetables and dried chili pepper are being established.

XII. Economics.

In cooperation with other related agencies, the vegetable research program in socioeconomics is aimed at increasing farmers' incomes. This

research has been categorized into two groups of activities namely farm management and marketing.

XIII. Farm Management.

Vegetable cultivars which have been selected based on their overall performance are tested in demonstration plots of 0.25 to 1 ha. The local farmer's cultural method is used as control.

Economic analysis of current farm management practices in several vegetable production areas of Java have been conducted covering potato, cabbage, tomato, shallot, and garlic. Large differences in production costs of potato, tomato, and cabbage have been observed among 3 centers in West Java. The highest production cost was about twice as large as the lowest production cost. The difference is due to the amount of fertilizer and pesticides and the intensity of labor.

XIV. Marketing.

Marketing research is still in the initial stage. Surveys on vegetable marketing channels have been conducted. The areas of emphasis in marketing research include market organization, structure, and development. Research in the last 2 aspects should be done in cooperation with other related agencies.

It is often considered easier to increase vegetable production than to market the produce. In certain aspects, this statement is true and also indicates the importance of marketing. Sometimes, farmers do not harvest their cabbage crops because the price is very low and the income would be merely enough to pay the costs of harvest. At present, the main problem in vegetable marketing is the absence of a strong farmers' organization which could sell their produce collectively and efficiently. In other words, the producer is in a weak bargaining position.

Some HRI Research Achievements

White Potato

a. High yielding potato varieties and hybrids have been developed; viz., Rapan 106, Rapan 181, Donata, and Desiree.

b. The application of chemical plant regulators such as 20 cc CS_2/m3, 9 ppm Gibberell in GA_3 and 20g calcium carbide/kg reduces the resting period of potato seed tubers to about 2 months.

c Fertilizer dose for potato is recommended at 150 N-100 P_2O_5-100 K_2O kg/ha

d. Orthene 75 SP (0.75% active ingredient) is effective against *Phthorimaea* in the field.

e. *Phytophthora infestans* can be controlled by various fungicides in order of effectiveness: Maneb-Brestan, Difolatan 4F, Polyram M, and Vondozab applied at 6-day intervals.

f. Potato processed into dehydrated potato chips by pretreatment in lime water or $CaCl_2$ solution can be stored for more than one year in polyethylene bags.

Tomato

a. Of 75 tomato varieties and hybrids introduced from the Netherlands, England, America, France, and Israel . 4 entries were promising, viz., No. 497 VF, No. 311 FR, Ronald V 75005, and 2100 with average yields of 0.7 to 1.12 kg/plant.

b. High yielding cultivars and hybrids of tomato include Money Maker, King cross SG, Panase F 70, Efet, Monalbo, Bonset, and Geraldton, AVRDC Acc. 15, and Acc. 33 for lowland cultivation.

c. Fertilizer for tomato is recommended at 100 N-100 P_2O_5-50 K_2O kg/ha and 30 t/ha of stable manure.

d. Weekly pest control with Supracide 40 EC, Lannate 90 WD,or Bayrusil resulted in high tomato yields.

e. Vondozeb, Dithane M-45, or Difolatan 4F provided effective control of *Phytophthora infestans* in tomato.

f. The tomato varieties AVRDC Acc. 33, 24, and 15 were highly resistant to bacterial wilt.

Cabbage

a. The high yielding varieties and hybrids of cabbage are Oceana, KY cross, NS cross, Titan 90, KK cross, Nagano, and Dutchman. Yields varied from 36 t to 63 t /ha, depending on the amount of fertilizers applied.

b. Fertilizer for cabbage is recommended at 100 N-100 P_2O_5-100 K_2O kg/ha and 30 t/ha of stable manure.

c. Mixed cropping of cabbage/leaf onions and cabbage/red bear/leaf onions showed promising results.

d. The use of *Angitia* as a biological control against *Plutella* gave promising results.

e. Selective insecticides for the control of *Plutella* are Dipel, Tamaron 200 LC and a mixture of Dipel WP, Bayrusil, and Hostathion 40 EC.

f. The assessment of the breakeven point of cabbage farming and a survey on marketing channels have been conducted.

Chinese Cabbage

a. Granat, Nagaoka, Selesta, Waka, and Alabasta produced higher yields than the other introduced cultivars.

b. The application of 2000 ppm Gibberellic acid on the plant canopy induced flowering and seed formation in Chinese cabbage.

c. The fertilizer requirements of Chinese cabbage and white cabbage are the same.

Cauliflower

a. The highest yielding cultivars are Cirateun (which was developed locally), Kibo, Giant, R2002, and Snow Diana.

b. The performance of the local cultivars Cirateun is better than the introduced lines and it can produce seed.

c. The fertilizer requirement for cauliflower is recommended at 135-N-100 P_2O_5-(0-100)K_2O.

DISCUSSION

Opeña: I presume when you talk of limited production areas, you are referring to highland production regions. Are you also considering potential areas, especially warm lowland regions where new varieties of radish, white potato, or cabbage can be grown with the advent of possibly new, heat-tolerant types?

Hansani: We have to consider that Indonesia has 130 million inhabitants with 80 million in Java which has only 7% of the total arable land, whereas the rest of the population is located in the other islands such as Sumatra, Kalimantan, and Sulawesi. You can produce vegetables in these other areas but problems of transportation and communication would be encountered.

Sumatra and Sulawesi are potential areas for vegetable production.

Tsou: You have selected several vegetables to study in your institute. Why did you select these particular vegetables?

Hansani: The highland types of vegetables grown commercially in Indonesia such as potato, tomato, and cabbage were chosen because of their economic importance. Mushroom also has market potential Chili is also an important commodity but it is grown after lowland rice and the production was about 300,000 t/ha in 1973.

Calkins: Would you be interested in having your selections reviewed in terms of economic importance? Is there a possibility of including other vegetables?

Hansani: Yes, we would welcome a review in this regard. But for the moment, we are concentrating our efforts on the types we have identified.

Calkins: A related question is the problem of defining "vegetable". The project that we are evolving is interested in including legumes and root crops under such a definition. I understand that in Indonesia, these crops are categorized separately from vegetables and are studied by other institutes. How would we resolve this problem if Indonesia is included in the network?

Hansani: We have other central research stations in Bogor which study soybean, mungbean, and sweet potato. Arrangements can be made to involve them in such projects as you may have in mind. We know the people there.

Somporn: What is the most important vegetable crop that Indonesia exports?

Hansani: Small quantities of white cabbage, potato, and Chinese cabbage are exported to Malaysia and Singapore.

Somporn: What about chili?

Hansani: Yes, we export chili but not on a regular basis because production fluctuates. We export chili in dried form to Japan and the United States.

Pritana: How do you transport your vegetables, besides chili, for export?

Hansani: We use ferry boats to transport fresh vegetables from North Sumatra to Singapore and Penang. The vegetables are packed in baskets.

Pandey: What is the production profile for turnip, carrot, onion, and radish in Indonesia?

Hansani: Onions are produced in small quantities. Shallot production is quite considerable. Not much carrot is planted; it is grown in the highland and marketed in the towns and cities. Turnip is not grown and radish is grown in small quantities, mainly for the Jakarta market.

Anothai: What about Chinese radish?

Hansani: Yes, that is planted too, but only in small quantities. We call it lobak.

Anothai: Do you also use it as a salted vegetable?

Hansani: I don't think it is popularly eaten in Indonesia.

Anothai: Would you consider exporting it to other countries?

Hansani: Not at the moment.

Yang: What would make white potato acceptable to the Indonesians?

Hansani: White potato is mostly cooked with soup and casserole. It is not used as a single dish as in other countries but consumption is quite considerable.

Yang: In case of rice shortage, can white potato be used as a substitute by your people?

Hansani: The problem is white potato requires intensive management. Production costs are quite high, i.e., $7,000/ha. Damage caused by *Phytopthora* is also considerable. We would need intensive plant protection methods.

Yang: Have you identified specific areas where white potato can be grown with less disease problems?

Hansani: It can be grown only in the highlands in the dry season. It is risky to grow it under wet conditions. The cool, dry season is best for potato growing.

Yang: We have some cultivars resistant to early and late blight. The cultivars which have shown resistance to late blight have been tested in areas where the climate is not humid. Thus, serious outbreaks of late blight have not been encountered in the lowland. But since our trials are conducted under artificially induced epiphytotic conditions, the resistance to late blight may be substantial. Our objective at AVRDC is to develop varieties for tropical lowland.

Hansani: Investigating the growth of white potato for testing and selection under humid lowland conditions would be very interesting. We have noted that the total production of sweet potato is more profitable than white potato in Indonesia. Sweet potato is also more adaptable to both lowland and highland culture.

Senanayake: This workshop can identify which crops could be grown more intensively in specific areas considering water availability and resistance to diseases. Also, some vegetables are more suited to dry or wet periods. The survey that this project is undertaking would be very useful in this regard.

In your list of priorities, there is no mention of legumes. Is this because you don't have any problem in legume production or don't you have any use for it in your country?

Hansani: Our list can still be changed. This was developed in a meeting in 1973.

Calkins: What other vegetables would you consider?

Hansani: We could include soybean. But as I mentioned earlier, the Bogor station is responsible for soybean research.

Anothai: What about yardlong beans?

Hansani: We don't grow many yardlong beans.

Castro: Regarding manpower development in Indonesia, what steps has the government taken to upgrade the capability of agricultural manpower?

Hansani: The government has developed such programs but because of limited funds, only a few could be trained. Also, we need more fellowships to have our people trained abroad.

Castro: The World Bank is supporting a program to send research station personnel for training. Are your people included in this program?

Hansani: Yes, but I don't know how many of them are participants of this program.

Opeña: Do you export to Malaysia and Singapore because of over-production or is it because farmers can earn more by exporting their produce?

Hansani: The vegetable market in North Sumatra is very profitable and competitive. The farmers channel their produce there. The export market is just as profitable.

Haque: What is the contribution of vegetable production to GNP? Wouldn't you think that your program of backyard gardening might adversely affect the farmers?

Hansani: I can't exactly quote right now the value of vegetables in the GNP. I cited it in one of my papers which I can make available to you after this session.

As to your second question, the consumers of market vegetables mostly

belong to the middle and upper classes. The lower class relies mostly on backyard gardening for home consumption. It is this group of people who would benefit most from this program.

Calkins: In that case, you would have a situation where backyard gardening augments market supply, especially in densely populated areas.

What other programs for vegetable production do you have? How would you assess the relative importance of backyard and commercial vegetable production?

Hansani: Backyard gardening is important in cases of meager supply.

Bautista: What percent of the area grown to vegetables is classified as highland? Are there research or field stations in these areas?

Hansani: We have highland areas in West Java, East and Central Java, North Sumatra, and Sulawesi. There are stations in the first 4 areas.

Calkins: Especially in Java, what are the different types of production environment?

Hansani: A mountain range runs from North Sumatra along the West Coast through Java, the Lesser Sundra Island to West Irian. These are potential areas for growing vegetables. Sulawesi is also bounded by a mountain range.

Calkins: What are the principal seasons in the lowland?

Hansani: It is wet from July to August and September and dry from November to February. The eastern part of Indonesia has a lower rainfall for up to 4 dry months compared with only 2 months in the western part.

Senanayake: How high is the highland area for vegetable growing?

Hansani: From 600 m above sea level upwards to about 1500 m or even higher.

Yang: Since your project for small farmers is concentrated in East Java, is this in line with your government's program on redistribution of population in this area?

Hansani: We want to encourage transmigration. Java has a population of 80 million and the rate is increasing at 5%/yr. Also the industrialization program of Java would depend on healthy workers.

Yang: Is this project being developed as a model for other areas?

Hansani: Yes, we need to generate action oriented activities and less theorism.

Yang: What is the role of researchers in this project?

Hansani: Some staff members of universities and experimental stations conduct preliminary surveys. They also conduct socioeconomic surveys.

Anothai: How do you obtain seed materials?

Hansani: White potato and cabbage seeds are imported from other countries but we produce tomato, cauliflower, and legume seeds ourselves.

Senanayake: In vegetable production, sometimes high dosages of pesticides are used which are not desirable. Are you also working on biological pest and disease control?

Hansani: Commercial growers rely more on chemical control. They use maximum dosages. But we have begun to explore methods of bilogical control. We have encouraging results in controlling *Plutella* on cabbage in West Java but not in North Sumatra.

Calkins: Do you have climatic data on temperature, rainfall, and humidity? As we identify potential areas for vegetable development, we shall need these data.

Hansani: We have these data but I did not bring them with me. I could make them available to you upon my return.

VEGETABLE PRODUCTION IN A DEVELOPMENT CONTEXT

Somporn Drabyasara and Anothai Choomsai[+]

Just like any other developing country with a rapidly expanding population, Thailand needs to improve its agricultural system to produce more and better quality products. The estimated population of the country is a little over 40 million which is expected to double in the next 20 to 30 years. With more people to feed, agricultural production must be modernized to bring about higher production per unit area, and farmers must be assisted to become better educated and more informed. Thailand must have more and better prepared agricultural professionals who are able to translate their theoretical knowledge into practical results in the field.

Progress in agriculture in the developing countries usually means simultaneous advances in several social and technical areas, particularly in research, teaching, and extension. In addition to researchers, teachers, and extension workers, a large number of technical people are needed to meet the growing needs of agriculture and to run the multitude of agricultural business enterprises that arise as agricultural development attains industrial and commercial stature. Trained personnel are needed to run the government regulatory agencies and supervise bank and government loans. Agriculture also requires well trained people to manage, own, and operate the large corporate farming enterprises which appear to be effective for most agricultural crops in relation to capital investment and manpower input.

The expanding agro-industry in Thailand is a case to raise for discussion. There is a great need for managers, assistant managers, and technical supervisors for field operations such as fertilizing, irrigation, and cultural practice for specific crops. People who are knowledgeable in pest and disease control, and who have a good understanding of herbicides and other chemicals are needed. The need is not only in terms of quantity of trained technical people but, perhaps more important, of the quality of their former training as well as relevance and diversification of their skills. Any new horticultural industry for the export market will need an abundance of graduates who have undergone a vigorous training of learning by doing.

Export corporate farming of perishable horticultural products is based primarily on quality. The production of a high quality crop and the maintenance of high standards for shipping long distances requires an advanced degree of technology and the professional understanding of the various operations from seed planting or propagation until the ultimate product reaches the consumer's table, often many thousands of kilometers away from the production area. Technology must improve horticultural varieties that are suitable for tropical conditions also. Therefore, the training of competent plant breeders must be the first priority in efforts to upgrade horticultural production.

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[1]Manpower Planning Division, National Economic and Social Development Board, Bangkok, Thailand, 1974.

According to the Fact Book on Manpower in Thailand[1], 4367 graduates have graduated in agriculture and related fields in a period of 7 years, 1966 to 1972. This figure includes 1392 who received diplomas from all vocational colleges in the country and 2975 from the three agricultural universities, Kasetsart, Khor-Kaen, and Chiang Mai. For a country with a population over 40 million, 609 graduates per year in all the fields of applied biology is not enough. This number is still not sufficient to supply all the needs of an agricultural industry which contributes roughly one-fourth of the gross domestic product of the entire nation.

Table 1 shows that horticulture products constituted 22% of the whole agricultural production of Thailand in 1973. Vegetable production also includes dried chillies, dried garlic, dried onion, cardamon, leafy vegetables, root crops, bulb crops, cucurbits, cole crops, and spices.

Table 1. Thailand's regional gross domestic product for agriculture, 1973[a].

Sector	Gross Domestic Product				Total	Percent of total
	NE Thailand	N Thailand	C Thailand	S Thailand		
	(million US$)					%
Agronomy	431	379	430	59	1299	45
Horticulture[b]	155	134	216	129	634	22
Rubber				136	136	5
Livestock	85	69	88	275	275	10
Fisheries	26	19	171	127	343	12
Forestry	35	61	25	25	182	6
Totals	732	662	966	509	2869	100

[a]The statistics presented here are estimates and were obtained from National Income of Thailand, 1972-1973 Ed. Vol 6 (Gross Regional Product) March 1974. [b]The figures here do not reflect the value of ornamental crops such as orchids, for the local market and for export, and the value of other marketable flowers, nursery stock, and turf It is also highly doubtful whether the figures for fruits and vegetables reflect the true picture because the great majority of the production comes from backyard orchards and gardens which are not included in the statistical annual report.

The value of imported vegetables was more than the exported value.

1970 imported value = US$ 253 million.

1975 imported value = US$ 414 million.

1970 exported value = US$ 51 million.

1975 exported value = US$ 79 million.

The increasing value of exported vegetables can be analyzed by studying these figures carefully. One can determine from the figures which

vegetable crops can be grown for export. An Agro-Industrial Plan should be made immediately based on the Vegetable Crop Map and cooperative organizations that can fill the production gap. Another possibility is to decrease the vegetable imported value by increasing vegetable growing area through multiple cropping and growing vegetables that are suitable for subtropical condition. In hilly areas, more crops such as potatoes, onion, shallot, garlic, cabbage, cauliflower, Chinese cabbage, mustard, and broccoli can be grown.

Statistics on the country's vegetable production are apparently non-existent despite the fact that Thais consume a large amount of vegetables. Farmers can grow 3 to 4 vegetables crops per year by observing a multiple cropping system so that production of local vegetables is not constrained by seasonal fluctuations. This is not accurately reflected in the annual statistical yearbook of the Ministry of Agriculture and Cooperatives, but the year-round abundance of vegetables in the wholesale market indicates the economic importance of these crops. Production and yield data are presented in Table 2.

Table 2. Cultivated area and yields for some vegetables in Thailand, 1974.[a]

Crops	Cultivated area	Harvested area	Yield	Production
	----------(1000 ha)---------		(t/ha)	(1000 t)
Capsicum (large)	82	79	0.8	60
Capsicum (small)	116	113	0.6	64
Garlic	84	83	1.8	150
Chinese radish	22	22	4.1	90
Tomato	16	16	2.1	34
Sugar peas	6	6	0.8	5
Cabbage	29	28	3.6	101
Shallot	68	67	2.6	177

[a]Unpublished data from the Department of Agricultural Extension, Ministry of Agriculture and Cooperatives.

Because data on vegetables are lacking and not up to date, daily fluctuation of vegetable prices occurs. When farmers want to grow vegetables, they cannot determine the size of the planting area for particular kinds of vegetable crops. So they have to imagine that if they grow Chinese cabbage now, for the next 60 days the price of Chinese cabbage should be $0.20/kg. However, at the harvesting period the price may decrease to 0.05/kg.

When the area planted to a particular kind of vegetable decreases, the price becomes high. The farmer knows that if he grows off-season vegetables he will likely get a high price.

It can be stated that with the present available data, it is difficult to make a quantitative prediction of Thailand's future needs for vegetable production and land area.

The fact is, at the moment, the demand for horticultural products in Thailand is increasing. Many big factories operate only 3 to 4 months a year because there are not enough raw materials to process, particularly pineapple, asparagus, baby corn, tomato, peas, and cucumber mushrooms. This means that the vegetable growing area must be increased.

The difficulties that Thailand is facing in its attempt to upgrade vegetable processing are:

1. Lack of suitable varieties for processing.

2. Lack of extension people who will convey the technology to the farmer.

3. The failure of the cooperative system of production.

4. The failure of the contract system between farmers and processing plants.

In the face of these problems, Thailand has many assets as an agricultural country. It has fertile soil, enough water supply, and low labor costs. All these will stimulate greater export for processed vegetables and fresh vegetables in the near future.

Vegetable seed production is an important factor for vegetable growing.

In 1974, Thailand imported 90% of its vegetable seed requirement from Taiwan, U.S.A., and Japan. They have a contract with many seed dealers in Thailand. In case vegetable growing is increased in Thailand in the future, Thailand will have to import more seeds at an estimated cost of $50,000/year. In 1974, the value of all imported vegetable seeds was $80 million, including those used for food and industrial purposes.

Many kinds of economic vegetables are grown from imported seeds. In July 1974, the following seeds were imported.

Chinese kale	37.7 t
Chinese radish	14.6 t
Cabbage	12.2 t
Celery	5.8 t

The vegetable seeds imported in 1973 totaled 285 t, and in 1974, during a period of only 8 months, 263 t of vegetable seeds were imported. These figures are only from the Department of Customs, Bangkok Harbor. More seeds could have been brought into this country by other means.

Research on vegetable production in Thailand is concentrated on breeding and selection to develop varieties that can supply the fresh vegetable market and provide raw material for the food processing industry. To reduce the quantity of imported seed, a seed production industry or even a small scale seed growers' business should be established.

Acts to establish and protect the seed industry have been drafted since 1970 and were approved by the Parliament in 1975. At the moment,

the details of rules and regulations are being carefully studied and will be declared by the Ministry of Agriculture and Cooperatives as a tool for seed quality control. Decrees are expected to be announced very soon. Seed quality will be improved greatly when the government can control seed quality, and promote the seed production business.

Potential research work should concentrate on the improvement of commercial vegetable production in Thailand in the following areas:

1. Varietal improvement to obtain insect and disease resistant varieties, better yield through hybrid vigor, and high nutritive value.

2. Seed production and seed quality control.

3. Post harvest technology including storage, packaging, and handling of the raw material.

4. Vegetable forcing of suitable varieties for off-season production and modification of production technique.

5. Application of insecticide, fungicide, and herbicide.

6. Fertilizer and soil improvement.

7. Vegetable marketing.

To accelerate the progress of vegetable research, the committee for research and development in vegetable crops was formed both at institutional and national levels. This committee is composed of research workers from several fields of specialization, including taxonomy, cytogenetics, breeding, physiology, tissue culture for plant breeding, entomology, pathology, soil science, virology, and marketing. The master project was approved at the institutional level (Kasetsart University) to set up the priority schedule for different crops. At present, vegetables are considered a second priority to cereals in terms of financial support, but the budget is still very limited to meet the needs of the vegetable industry.

If Thailand could get some support from international organizations such as AVRDC, FAO, SEARCA, or foundations which provide research funds to establish a Research and Development Institute for Vegetables, this would be a great contribution not only to this region but also to other tropical countries.

Well-trained scientists from different fields in this country are ready to cooperate and solve the various problems concerning vegetable production. In addition, climatic conditions in the country are favorable for the growth of different kinds of vegetables.

DISCUSSION

Tsou: What percentage of your university graduates go into farming or work on the farms?

Anothai: Quite a few go to the farms. We have more colleges of agriculture now, and vocational schools of agriculture are also providing trained manpower for farming enterprises. Of course, many of the university graduates become teachers, researchers, and extension workers, and some go

abroad for further studies. All them contribute to agricultural development.

Tsou: Graduates of agricultural schools also shift to industry in Taiwan.

Calkins: Which of the crops tested in Table 2 would you rank as the top six crops to be included in the network?

Anothai: I would include capsicum, peppers, tomatoes, cucumbers for pickling and fresh consumption, cabbages, and garlic.

Calkins: Which would you consider as the most important crop?

Anothai: Tomato or Chinese cabbage for fresh consumption, and chili.

Calkins: Which of the legumes would you consider as the most important?

Anothai: Yardlong beans.

Castro: What is the rate of mobility or job turnover among your trained people?

Anothai: Our people have been observed to stay long on the job. Also people are more specialized now and they tend to stick together as a group. We have been working together in the past four years through the national vegetable research committee.

Opeña: One potential area for research in vegetable production is seed production and seed quality control, especially with crucifers. Do you have areas suited to this type of study which would have a prevailing cool temperature to induce flowering and prolong seed viability?

Anothai: Yes, we have a few areas; some in north on Thailand and another in northeast Thailand.

Pritana: In Chiang Mai, the average temperature is 23°C; the maximum temperature is 35°C and the minimum is 7°C.

Somporn: Our biggest problem is blight which attacks white potato and tomato, and purple blotch infecting onion. I would like to add also that we have seed stations in the north to solve our seed production problems.

Calkins: In the network, some countries could be designated as seed production areas. Nepal's role, for instance, could be the production and distribution of disease-free and pure seeds.

Each country can have its own seed centers, but considering the cost and quality of seed, this may be more expensive than having only specific countries produce and distribute seed materials to the rest of the countries in the network.

Yang: You mentioned that seed production is a problem in Thailand. Therefore, you have to continuously import seed. What are your problems in local efforts to produce seed and do you have plans to expand this venture, especially for disease-free seeds?

Anothai: We have resorted to seed importation in some crops because we

cannot produce seed profitably; for example, seeds of carrot, broccoli, Chinese radish, Chinese cabbage, and common cabbage.

We also have to look at the credit system which is commonly observed by vegetable farmers in Thailand. In the credit system, the middleman obtains all inputs such as seed, fertilizer, and other purchasable inputs. This is a form of indirect control As it happens, these middlemen are mostly Chinese who have direct access to seed companies in Taiwan and Japan. This practice can be liquidated by law, but this will take some time.

Yang: Perhaps, if the government can demonstrate that you can produce seed locally and couple it with a sound seed certification program, it would be easier to establish a seed industry.

Somporn: We have no seed company in Thailand yet. The universities and the Department of Agriculture have taken an active role in seed production, but as in sweet corn, leafy vegetables and root vegetables, they can produce only 20% of the total requirement.

Anothai: We also need seed processing plants. We have only one in the north.

Tsou: Are processed vegetables for export? If this is the case, what is the local consumption situation?

Anothai: We have enough vegetables for local consumption.

Calkins: You mentioned a national committee on vegetable research and development. Who are the members? Does the committee interact with farmers?

Anothai: May I refer that question to Mrs. Somporn who is the executive secretary of the committee.

Somporn: The committee was organized four years ago at Khon Kaen University. The committee is composed of members from 3 universities, the Department of Agriculture, Department of Agricultural Extension, and the Department of Irrigation our basic objective is to bring to the farmers information on improved technology and seeds of improved varieties. We conduct seminars and hold demonstrations to determine the problems of vegetable farmers. Lately, we have dealt with guidelines in harvesting for maximum profit as well as processing techniques.

Calkins: How many meetings have you had and where do you usually meet?

Somporn: We meet 3 to 4 times a year in various parts of the country and we hold a seminar once a year. We included dialogues and seminars with farmers only this year.

Calkins: Do you find the participation of farmers useful in your work? Are they responding?

Somporn: Yes, the farmers are responsive to our activities.

Senanayake: Why do rice growers and watermelon cultivators rotate their crops in the same fields? Cannot the rice growers also cultivate watermelon during the different seasons?

Anothai: Watermelon requires a special technique for growing. We usually grow it near the canals because of the moisture. However, not all farmers can grow watermelon.

Senanayake: What other vegetable crops are grown after lowland rice?

Anothai: Growing baby corn after rice is quite popular also.

Senanayake: Would you consider growing specific vegetable crops in particular regions, as in area specialization for maximum production at less cost?

Anothai: That would depend on the eating habits of the people. A region normally produces for their needs and, hence you will find cabbage grown everywhere. Also, we can grow any vegetable crop anywhere, so there is really no need to regionalize vegetable production.

de Padua: Regarding the absence of seed processing plants, is this because you lack financial support to obtain facilities and equipment or is it because you lack the technology in this aspect?

Anothai: We already have the technology, but we do not have money to construct the necessary infrastructure.

de Padua: The reason I mentioned this is we have an Asian grain processing project and Thailand is a participant in this project where facilities for processing will be developed. There seems to be some lack of coordination here.

Nishi: Because of the diversity of cropping requirements of different vegetable crops, how do you conduct you extension work on vegetables?

Banchong: The Department of Agriculture and the Department of Agricultural Extension cooperate on matters of extension services. As it is practiced, one extension man in a specific area takes care of all crops and not only the vegetable crops that are grown in the area. The problem is we do not have enough extension people. We also do not have enough positions for extension workers.

Somporn: At the moment, we practice team work. For instance, the staff members of Kasetsart University and Chiang Mai University working on vegetables formulate joint project proposals for funding. As part of the project, we conduct demonstration plots and lecturers to apply our research results under farm conditions. Processing techniques are also included in these activities. We sometimes go to the farmers to follow up what we have introduced.

Pritana: These demonstration activities are divided into three stages. First, we do the work and show the farmers how we do it. Second, the farmer does it with our guidance. Third, the farmer repeats it without any help from us. Then we compare the results.

Somporn: Using the demonstration techniques, we have succeeded with grapes and orchids. It will take longer for vegetables.

Castro: But these are university programs only. How are the provinces that are far from the universities covered by these demonstration services?

Anothai: We do not limit ourselves to the vicinity of our institutions. Also, the Ministry of Agriculture links up with the university in conducting these demonstration plots.

Calkins: We should remember that there can never be enough extension workers in any given place. One way to maximize the services of well trained extension workers is to limit their specialization to specific crops. Their effectiveness could further be enhanced by having them work in specialized agroclimates.

CROPPING SYSTEMS INCLUDING VEGETABLES

Pritana Pradipasen[+]

Cropping intensity and the type of cropping pattern are influenced by the physical, economic, and social resources, and the environment. Thus, a knowledge of the environment in which man works and how the environmental factors limit cropping potential is important. By cropping pattern I mean the annual sequence of crops and its interaction with the physical and biological environment.

There is a need to understand the physical and biological potential of target areas to be able to design efficient cropping patterns. If these patterns are to be used as viable cropping systems, their resource requirements must correspond with the potential resource availability.

The cropping systems are dependent upon environment, the environmental parameters that affect them must be identified. These parameters include:

1. Climatological factors such as solar radiation, the variables of water balance and temperature, wind, and storm frequency.

2. Soil factors, such as water holding and movement characteristics, fertility, and tillage potential.

3. Topography, especially in relation to hydrology.

4. Irrigation potential.

5. Economic factors, such as farm size, human population and labor availability, market availability, and farm power.

Within Southeast Asia, the cropping pattern's physical potential is primarily determined by topography and water availability or excess water. The third limiting factor is tillage potential. Although soil fertility has a smaller effect on cropping pattern, it influences crop management.

Vegetable Growing in Chiang Mai

Chiang Mai Valley is situated along the Ping River, between 18°13' and 19°15' north latitude and 98°50' and 99°10' east latitude in the northern part of Thailand. The average altitude is about 300 m above sea level. The climatic condition is most suitable for growing vegetables and all other kinds of crops. The average temperature is about 24°C with the maximum temperature of 35°C and the minimum temperature of 7°C.

The fertile valley has about 150,000 ha of cultivated land. Most of the land is irrigated. However, the average farm size (1.4 ha) is considered to be relatively small compared to the national average farm size (3.9 ha). Rice land occupies about 75% of the area; the rest of the area is planted to vegetable crops and fruit trees. Because of limited land area, mounting population pressure, and unfavorable natural conditions, intensified land use becomes an important strategy for increasing agricultural production in the valley.

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There are many kinds of vegetable crops grown in the valley. Among the more commonly grown types are garlic, onion, tomato, pepper, chili, and all kinds of *Brassica* sp. The volume of production is adequate to supply only the needs of the local market, especially in the dry season. Table 1 gives the total area grown to vegetables during the dry season under an irrigation project covering the period 1964-1973.

Table 1. Dry season cultivated vegetable area in Chiang Mai Valley Irrigation Project, 1964-1973 (selected years).

Year	Cultivated area		
	garlic	other vegetables[a]	total
	(ha)		
1964	1,104	96	1,200
1966	1,614	197	1,811
1968	1,971	207	2,178
1970	2,058	403	2,461
1972	2,827	752	3,579
1973	5,279	1,229	6,508

[a]Vegetables consist of *Brassica* family, tomato, pepper, lettuce, cucurbits family, onion (shallot), etc.

Source: Agricultural Statistics, Royal Irrigation Department, Chiang Mai.

Traditional Cropping Systems

The cropping system practiced in the valley depends on seasonal variations. Rice is the main crop during the rainy season. So, the cropping systems including vegetable crops begin with rice.

Some farmers are engaged in rice cultivation twice a year. In this case, they do not include vegetable crops in their cropping systems. The traditional cropping systems including vegetables are summarized in Table 2.

Multiple Cropping Project, Chiang Mai University

The Multiple Cropping Project conducted by the Faculty of Agriculture, Chiang Mai University has the following objectives:

1. To develop, adapt, evaluate, and assist in the dissemination of new technology relating to ecologically sound systems of multiple cropping that will substantially increase net income per farm.

2. To develop the university's research and training capacity so that a sustained program of applied research can be established and internalized.

Table 2. Traditional cropping system including vegetable as practiced by farmers in Chiang Mai, Thailand.

System	Month		
	rainy season	cool-dry season	Hot-dry season
	Jul Aug Sep Oct	Nov Dec Jan Feb	Mar Apr May Jun
1	Rice	←Garlic (onion)→	
2	Rice	←Cool season vegetable→	
3	Rice	←Tomato (local cultivar)→	

The criteria used for developing cropping systems are as follows:

1. Available germplasm and technology for:

   a. Suitability of growing season.

   b. Insect and disease control potential.

   c. Soil and water needs and conservation.

2. Net farmer income and market potential.

3. Farmer interest and familiarity.

Several cropping systems involving vegetables were tested in this project (Fig. 1).

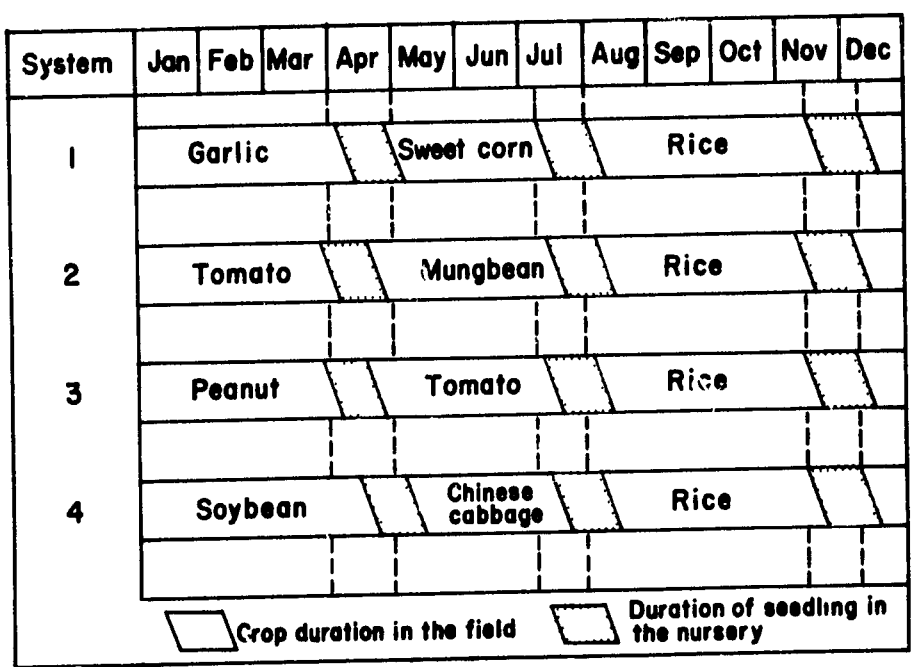

Fig. 1. Cropping system tested at the Multiple Cropping Project Experimental Plots, Chiang Mai University 1975-1976.

Among the vegetable crops listed above in the cropping systems, garlic cultivation occupies a relatively larger area than the other crops (Table 1) and usually contributes more significant returns to the farmers, but it is a risky crop.

Tomato is a common crop in the cool season. All existing tomato varieties are well adapted to the area. However, the tomato cultivar VC 11-3-1-8, which was selected from AVRDC, is most suitable for the hot season.

Sweet corn is a new crop and has a good marketing outlet. However, existing varieties of sweet corn and Chinese cabbage are not suitable to hot season production.

Yield and Budget Analysis of Cropping Systems

Data on yield and budgetary cost of production of 4 cropping systems involving vegetable crops either as the second or third crop for the period November, 1975 to November, 1976 have been analyzed and are shown in Table 3.

Table 3. Actual cropping system budgets for 1975-76 at the Multiple Cropping Project Experimental Plots, Chiang Mai University.[a]

System	Crop	Yield	Gross return	Cost of production		Net income	
				with labor	without labor	with labor	without labor
		t/ha)	(US$)				
Wet	Rice	5	76	54	35	22	41
Cool	Garlic	11	268	284	176	16	92
Hot	Sweet corn	11	127	52	40	74	86
	TOTAL	-	471	390	251	80	219
Wet	Rice	6	79	48	28	32	51
Cool	Soybean	2	95	92	69	3	27
Hot	Cabbage	6	110	58	37	52	73
	TOTAL	-	284	198	134	87	151
Wet	Rice	5	69	43	29	26	40
Cool	Peanut	2	113	81	50	32	63
Hot	Tomato	12	283	76	54	207	228
	TOTAL	-	465	200	133	265	332
Wet	Rice	5	72	57	40	16	32
Cool	Tomato	24	288	76	53	212	235
Hot	Mungbean	1	97	81	51	16	46
	TOTAL	-	457	214	144	244	313

[a]Includes only cropping systems that involved vegetables.

The data indicate that vegetable crops provide higher net return than any field crop, given the same area of cultivation within a cropping system. However, vegetable production incurs more risks than field crops. For instance, in the rice-garlic-sweet corn system, garlic is traditionally the main crop succeeding rice in the valley, and it is a profitable crop. But there was a deficit of garlic during November, 1975 which was mainly due to damage caused by an unexpected rainstorm. The major cost components in vegetable crop cultivation are seed, fertilizers, and chemicals. Tomato, sweet corn, and cabbage have heavy input costs with the use of fertilizers and chemicals for pest control; while garlic depends heavily on seed, fertilizer, and chemicals.

Among the cropping systems tested, the rice-peanut-tomato system showed highest economic potential. This was mainly attributed to the high price of tomato during the hot season.

Major Constraints

Some constraints that could impair the inclusion of vegetable crops in the cropping systems could be:

1. Physical

The majorattribute would be water availability at the time of cultivation, especially when vegetable crops are allocated in the third crop. The study of the efficient use of water is of major concern here. Under farmer field conditions, water supplementation from nearby wells is commonly observed. This is of great help in case irrigation water supply is not adequate.

2. Biological

Resistant crop varieties and disease and insect pest control seem to be of great concern. At present, spraying chemicals as a pest control measure contributes to the high cost of vegetable crop production. If resistant varieties could not be obtained, spraying programs should be scheduled efficiently to assure optimum yield. This then would involve monitoring pest populations, and rate and kind of chemicals as well as time of spraying.

CONCLUSIONS

The study of cropping systems including vegetables, as practiced in the Chiang Mai Valley, is an important phase of research at Chiang Mai University. Due to the lack of sufficient data available in cropping systems, it is too early to tell whether the recommended cropping patterns are better than the traditional cropping system observed by the farmers. The economic analysis of the systems grown in the experimental plots is being utilized to provide information for decisions on the development and improvement of subsequent systems, optimum amount of inputs, and comparative performances of alternative cropping systems.

The objective is not to maxmize yield using radically new management methods, but one of developing improved management systems that can be adopted and oriented to optimizing income.

Cropping systems including vegetables can be improved tremendously, provided that constraints are removed, and an effective program of extension is implemented. The possibility of cooperative research between and among the research institutions is worth exploring. The dividends from such cooperative effort should be high.

DISCUSSION

Pandey: Is asparagus grown in the highlands as well as in the lowlands?

Pritana: At first, asparagus was grown in the highlands. But now, we are growing it in the lowlands, especially in an area about 100 km east of Bangkok which has a large asparagus plantation. It is still planted in the north on a wide scale especially in the winter.

Pandey: What variety do you usually plant?

Pritana: Mary Washington from Taiwan.

Anothai: We eat the green spear as green vegetable and we harvest it when it has grown 15 to 18 cm from the ground. The beds are raised and the soil is sandy loam. At present, we cannot produce enough white spears for canning and export.

Pritana: Asparagus is an expensive vegetable. We have other crops being cultivated which are available at lower prices.

Calkins: The data in Table 3 are very interesting in terms of comparing labor costs. System 1 has labor costs of $140, System 2 $69 and Systems 3 and 4, $68 each. You have mentioned that under traditional pattern, which is most closely reflected in System 1, farmers grow more garlic. Is this because labor is plentiful? If so, chances for improving overall profitability through System 3 are very encouraging. The problem of rising labor costs is quite serious in Taiwan. It would be interesting to compare these figures with the situation in other countries.

Pritana: In the traditional system of farming, the family is the most common source of labor. The data is based on need for hired labor.

Yang: Under System 2 with soybean, yield is low and the cost of production is high. How do you explain this? In Systems 3 and 4, gross returns from tomato yield are almost the same in spite of a great difference in yield.

Pritana: Tomato in the System 4 is grown during the cold season while in System 3, it is grown during the hot season. The price of tomato is 5 to 6 times higher during the hot season. Regarding soybean, the low yield could be due to heavy insect damage, notably a small yellow insect probably called 'stink bug'. Also, the pods dry out before the harvest period.

Calkins: Have you made any statistical analysis to determine whether the influence of mungbean and soybean production on rice yield is significant?

Pritana: I am not aware of any significant yield increase in rice grown after mungbean or soybean.

Senanayake: In many instances, rice fields are left fallow during the drier season because water is inadequate for quick maturing vegetable crops. In your studies, has anyone determined water consumption patterns of different crops since this information could be used to increase the area under vegetable production in such regions?

Pritana: The water consumption of each crop has been recorded for studying.

Choi: What variety of garlic do you plant? Is the increase in production due to export or local government requirement? Do you have facilities for garlic seed multiplication?

Pritana: Yes, we have increased our production for export purpose. Our local consumption is relatively the same every year. We export 40% of our garlic produce, depending on how much we can produce. We use a local variety and a Taiwan variety. We have no seed multiplication facilities.

Calkins: Does Korea export garlic also?

Choi: No. We import because we often have a shortage of the commodity.

Banchong: We have 3 commercial varieties of garlic in Thailand. We have the small but strongly aromatic variety grown in the central plains, the Chiang Mai variety planted in Chiang Mai and Lumpoon area which is in the northern part of Thailand, and the last one is the local variety grown in the northeast. The Taiwan variety is a long day variety which is not grown commercially in Thailand. Regarding seed materials, the farmers keep their own seed stocks. They are planted in October to November and harvested in late February until March. Seeds are kept until the next growing season without spoiling.

Yang: Garlic has serious virus diseases. Plant pathologists resort to tissue culture for developing virus-free seeds to avoid using infested materials.

Opeña: The cost of production of cabbage in your study is low compared to mungbean and tomato. This seems unusual because cabbage is a highly intensive crop relative to the other vegetables. Moreover, the seed materials are also more expensive. How do you explain this?

Pritana: Mungbean and tomato were planted during the hot season. Seedling preparation took some time, labor, and money. The spraying program for tomato was more frequent than for cabbage. Also, the labor cost for harvesting is much higher.

Yang: In Table 1 for the period 1972-1973, the total acreage planted to garlic and vegetables doubled. It seems that the gap is quite unusual compared to the data in previous years.

Somporn: We have no updated data on acreage devoted to crops. But in the north, the farmers plant 4 major crops: rice, tobacco, fruits, and vegetables. A common practice is to intercrop vegetables with fruit trees. Now, even if area increases, the price of vegetables is still high if heavy damage occurs.

Pritana: Farmers plant the same crop if they see that the price during the previous year was profitable.

Calkins: Your systems all involve sequential cropping. Do you intend to study intercropping also? Could you not also look into other types of sequential cropping to maximize land use?

Pritana: Yes, we made a study on tomato and sweet corn and the results came out well. We have a 2-year grant for intercropping vegetables with fruit trees.

Somporn: Also, rainfall is not evenly distributed as in Taiwan, so farmers can't grow vegetables all the time.

Hansani: If sweet corn is included in System 4 instead of mungbean, the farmers may find this more profitable. In Indonesia, our farmers have found this more profitable. In Indonesia, our farmers have successfully incorporated sweet corn as an intercrop at profitable levels.

Pritana: This is only the first year of this experiment. We intend to rotate the crops to determine the most profitable scheme. Regarding sweet corn, I have tried planting it in the highland at a yield of 12.5 t/ha which was quite high.

Hansani: What is the average farm size in Chiang Mai?

Pritana: Most farmers in Chiang Mai don't own their land. They rent land for farming. Each farmer farms an average of 1.4 ha.

Tsou: What is the major objective of your cropping systems program? Is it for income or potential uses of the land?

Pritana: Our studies on cropping systems aim to find out ways for farmers to get higher farm income. But we are not in a position yet to introduce the system. We will test our systems for one more year.

Calkins: You can perform price-sensitivity analysis by varying prices by a given percentage. This will enable you to test whether the relative profitability of a system changes or not. If it does not change, you can be sure that the recommended changes are 'stable' in their profitability.

Castro: Regarding your cropping systems project, are you ready to train extension workers?

Pritana: Not yet. We are not pleased with the results relating to the first objective of the Multiple Cropping Project. Later, we intend to train farmers amd bring them to the center for 2 weeks to acquaint them with the things we are doing.

Castro: You mentioned that your farmers are not very receptive to multiple cropping technology. Why is this so?

Pritana: They have no money to invest. When you introduce a practice to the farmer, the first question they ask is about the cost involved.

Castro: The government can subsidize the venture on a pilot basis just to demonstrate its profitability up to a point that the farmers can better see for themselves the advantages of the technology.

Pritana: We could do that but we are not always sure of the varieties to plant until they find out for themselves.

Castro: In that case, the problem is we are not confident enough to give recommendations at this point.

Somporn: In Chiang Mai, the farmers already have a certain amount of expertise in multiple cropping, even more than the agricultural workers.

MARKETING VEGETABLES IN THE PHILIPPINES

Enriquetta B. Torres+

In a workshop sponsored by the Philippine Council of Agriculture and Resources Research (PCARR) in 1976, one of the participants, a businessman, assessed the vegetable industry in these words: "The industry of the country is somewhat anemic. Sometimes it is on its feet but most of the time it is flat on its back (1)."

Such despairing words would have been hard to believe except that the speaker had been a vegetable dealer of long standing and, therefore, was in a position to correctly diagnose the situation. The limitation of production inputs results in poor crop quality, hence low price and low net returns.

The rising cost of providing marketing services as well as the inadequacy of infrastructure for efficient product distribution may have contributed to the bleak situation. Filipinos consume about 80 types of vegetables of which only about 10 to 15 are important commercially.

On the production side, some notable progress has been made. While the area devoted to vegetables had been decreasing through the years up to the late 1960s, the average production per hectare had been rising. This indicates that technological improvements have already been achieved, although still at a relatively low rate boosting production from about 4 t/ha in 1965 to 5.2 t/ha in 1975.

The area planted to vegetables is only about 2.5% of the total arable agricultural land of about 7 million ha.

Undoubtedly agronomic research efforts have been mainly responsible for this trend. Part of the increasing productivity may also be due to the intensified attention given by the government to the industry in recent years which has been mainly in the area of production.

DEMAND FOR VEGETABLES

The compelling reason for the intensified concern over increasing the available supply of vegetables in the country has been the rising demand for the product as a result of rapid population growth. The importance of vegetables in the diet for a nation to be healthy is well known. However, present production rates are still inadequate to meet the nutritional requirement of the population. While estimated vegetable production is about 1.5 million t/ha, the estimated requirement is about 4 million t or a deficit of about 2.5 million t/yr(2).

The gross estimated volume of vegetable requirements reckoned in terms of recommended daily allowances, however, generally has not provided much incentive for the development of a vegetable industry. Although nutritionists may be right in identifying what and how much vegetable intake the people must have, it must be realized that most housewives in general

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do not feed their families based on dietetical science or nutritional knowledge alone. Economic factors play a big role in deciding what to feed the family especially among those with low income.

In a series of studies on food consumption patterns among Philippine households, Darrah and associate+ revealed that income is one of the major determinants in the intake of vegetables. In their study, they classified vegetables into four groups: leafy and yellow; fruit vegetables; leguminous vegetables; and roots, bulbs, and tubers. The first three types have rates of consumption that are directly related to income level. This means that as the income level goes up, the consumption of vegetables also increases. This may be due to the fact that higher income people are generally better informed and thus have a greater appreciation of the value of vegetables in the diet. The consumption pattern for root crops is irregular and does not seem to be related to income level.

The weekly intake of vegetables in the lowest income group was only 77% of that in the highest income group (Table 1). The types of vegetables more commonly eaten seem to differ also among income groups. Leafy vegetables, cabbage and pechay seem to be most preferred by the higher income group, whereas lower income groups consume more sweet potato tips and swamp cabbage (*Kangkong*), the so-called inferior foods, which have nothing to do with nutritional content.

Table 1. Annual per capita consumption of vegetables by income group, Philippines, 1975.

Annual per capita income	Type of Vegetable				TOTAL
	leafy and yellow	fruit	legu-minous	root	
(US$)	(kg/capita per yr)				
< 53	11	21	3	27	62
53 to 106	12	25	4	19	60
106 to 200	16	30	6	22	74
> 200	19	32	8	20	80

Source: Santos, C.L.G., et al. 1975. Income and food consumption (summary of 13 economic surveys). Special Studies Division Planning Service. Office of the Secretary, Dept. of Agr., Diliman, Quezon City, Philippines.

Eggplant and tomato are the leading fruit vegetables. Legumes often referred to as a "poor man's meat" are ironically the most expensive among the vegetables on a per unit weight basis (Table 2).

Prices may have a greater impact on the type and quality of food intake. Thus, even within vegetable groups there are some types with income elastic demands and some that are looked upon as inferior.

+A series of these studies has been conducted by the Special Studies Division of the Department of Agriculture, Philippines.

Table 2. Average prices paid for selected vegetable crops, Philippines, May-June 1975.

Type of vegetable	Price paid per 100 kilogram	Income elasticity of demand
	(US$)	(%)
Leafy and yellow		
Cabbage	24.4	74
Sweet potato	6.5	- 6
Kangkong	6.5	3
Pechay	20.0	62
Fruit		
Eggplant	15.5	16
Tomato	26.0	49
Squash	11.7	31
Leguminous		
Sitao	18.1	41
Mungbean	71.2	38
Root		
Sweet potato	7.5	-24
Onion	32.8	54

Source: Santos, C.L.G. 1975. Income and food consumption (summary of 13 economic surveys). Special Studies Division, Planning Service. Office of Secretary, Dept. of Agr., Diliman Quezon City, Philippines.

National Vegetable Programs

There are two national programs that aim to increase vegetable production: the Green Revolution and the *Gulayan sa Kalusugan* or "Vegetable Production for Better Health" Program? The Green Revolution emphasizes backyard vegetable growing, whereas the Vegetable Production for Better Health program is concerned with commercial scale vegetable production. Both are nationally coordinated programs to ensure adequate supply of vegetables for the country. But while the Green Revolution provides free vegetable seeds and also encourages other backyard enterprises such as livestock or poultry raising aside from vegetable production, the *Gulayan* effort is more along the lines of action presently pursued by the *Masagana* 99, which refers to a target of 99 cavans or 4.5 t/ha in rice yield. Clearly, therefore, the Green Revolution is kitchen oriented or more concerned with adequate nutrition for the households while the Vegetable Production for Better Health campaign is market-oriented.

Vegetable Production for Better Health Campaign

The vegetables included in the program were selected on the basis of nutritive contribution and commercial viability: bean, peanut, sweet or

green corn, sweet potato, squash, carrot, cantaloupe and watermelon, off-season tomato, cabbage, onion, and garlic.

The program was planned in such a way as to coordinate operations from planting to marketing. It provides supervised credit schemes for commercial production in priority areas. These efforts involved financing, provision of seed supply, fertilizers, chemicals, irrigation, marketing agreements, and extension education to be provided by various government agencies under the general supervision of the National Food and Agriculture Council (NFAC). It aims to generate production that would be enough to supply 25% of the estimated deficit in vegetable supply of the country. For the year 1974-1975, the target goal was 1.0 million t.

A management information system is envisioned as an effective reporting system. The management committee formulates the policies with the NFAC Executive Director as Chairman. An action officer directs and coordinates the program implementation.

For 1974-1975, the target goal was to utilize 105,200 ha for vegetable production in 25 provinces and one city. It was hoped this would generate a bandwagon effect among other growers. Both traditional and new areas will be utilized for vegetable production. In these areas, the trading post operation of the Food Terminal, Inc. (FTI) will handle the marketing aspect.

The production technicians will come from the Bureau of Plant Industry, Bureau of Agricultural Extension, Food Terminal, Inc., Bureau of Soils, National Food and Agriculture Council, and the U.S. Peace Corps. The field personnel will be given the same incentives and logistic support as those in the *Masagana* 99 program.

A marketing agreement or contract farming will be drawn up between the farmers and the Food Terminal, Inc. (FTI). The terms of agreement involve sale wither on consignment basis or by a guaranteed floor price plus profit sharing. Under consignment, the FTI will make commodity advances to credit institutions by at least 50% of the market value of the produce based on current wholesaler price ex-FTI or farm gate prices. In the second type of agreement FTI guarantees the floor price of priority crops which is equivalent to actual production cost and allowable profit margin of 20%.

The market information system which will be jointly operated by various government agencies, is to develop a reporting system for feedback information and accounting system. The information committees of other programs such as the *Masagana* 99 and the Green Revolution will be tapped to undertake the promotional and educational drive.

Table 3 shows the accomplishments of the program from July, 1975 to September, 1976.

The level of accomplishment for Phase II under the supervised aspect of the program, aside from farmers without credit assistance, still leaves much to be desired. However, in terms of efficiency of production per unit area, the figures are much better than the national averages (Table 4). We hope that with the lessons learned from past experiences, the program will improve its performance and meet its target goals for the future. The projected hectarage and production goals for 1977 to 1982 are listed in Table 5.

Table 3. Extent of accomplishment of "Vegetable Production for Better Health" Campaign from July, 1975 to September 1976.

Planting operation		Harvesting operation	
Farms with credit extension			
Target area (ha)	29,442	Target production (t)	230
Actual area (ha)	4,656	Actual production (t)	25
% accomplished	16	% accomplishment	11
Farmers served (no.)	4,137	Farmers served (no.)	4,063
Farmers without credit assistance[a]			
Target area	79,430	Target production (t)	827
Actual area	92,921	Actual production (t)	678
% accomplished	117	% accomplished	82
Farmers served (no.)	86,849	Farmers served (no.)	76,006

[a]Reached by information channels and extension services but not provided with material assistance.

Table 4. Average production by crop by region, Philippines.

Vegetable crop	Region									
	I	III	IV	V	VI	VII	IX	X	XI	XII
	(kg/ha)									
Tomato	10		13	13	15	6	20	20		
Sitao	12	13	6	11	7	6[a]				5
Sweet pea	2									
Baguio bean	8			9		4		2		6
Mungo	1	1	1	1	1	1		1		1
Squash		13	8	10	8					10
Cowpea	2	2								
Sweet potato	17	12	10	15	9				15	
Peanut	3	3	1	1	3			3	2	2
Carrot	13					13		4		
Cabbage	26		20	11	10	14		21	13	15
Garlic	5		6	2						
Melon		11	15	15	15			8		
Eggplant	12									
Bulb onion	15	20	16		10					
White potato	16									
Navy bean								15		
Sweet pepper							2			

[a]Based on Vegetable Production for Better Health provincial reports submitted by the respective provincial Program Officers for 1976-1977.

Table 5. Projected hectarage and production of the *Gulayan Sa Kalusugan* program, 1977 to 1982.

Year	With financing		Without financing		Total	
	area	production	area	production	area	production
	(1000ha)	(1000t)	(1000ha)	(1000t)	(1000ha)	(1000t)
1977	18	180	75	929	93	1,109
1978	20	198	110	1,357	130	1,554
1979	28	276	110	1,358	138	1,634
1980	43	431	129	1,592	172	2,023
1981	47	470	132	1,633	179	2,103
1982	51	512	136	1,674	187	2,186

From a free enterprise perspective, it is felt that the *Gulayan* program should not depend only on the Food Terminal Inc. for production disposal. The private marketing sector should also be involved in the marketing scheme. Perhaps, this will create an atmosphere of competition for the benefit of the growers.+ Furthermore, not all trading posts opened by FTI are operational throughout the year and, therefore, disposal will bottleneck since vegetables, being perishable products, require immediate disposal. Hopefully, with the cooperation of the private sector and the efficient coordination of the program administrators, the country's vegetable industry will be revived.

Aside from these, the credit institutions of the government, such as the Development Bank of the Philippines, are also extending loans to finance the operations of the vegetable growers (3).

THE MARKETING SYSTEM

Aside from the imperatives for improving the vegetable industry arising from supply and demand conditions, there are other compelling reasons why it should be developed. Foremost among them is the economic reality that vegetables give high net return per unit area as well as high nutrient yield per unit area. Unfortunately, the marketing system has not kept up with the progress in production and consumption.

According to Samson, "The present flow of vegetables from producer to consumer is one complex picture of inefficiency that has evolved through the years" (4). Duplication of marketing services along the marketing channel contribute to the high marketing cost of vegetables in the country.

+This had been mentioned by the NFAC Executive Director as already being done although it had not been cited in the program guidelines. See Panganiban, D.F. 1976. *Gulayan sa Kalusugan*: Its status and problems." Paper delivered at the National Vegetable Research Workshop. Central Luzon State Univ. (CLSU), Muñoz, Nueva Ecija, March 29-31.

There is only one primary market, which is Metro Politan Manila, while production areas are located all over the country.

The flow of goods along the marketing channel starts with the farmer selling his produce to the local or farm-level buyer. Then the produce is passed on to the trucker-merchant who transports it to market centers such as Metropolitan Manila where it's sold to the wholesalers. The latter deliver the goods to the retailers who, in turn, may pass on the product to another retailer who completes the final link between producer and consumer in the marketing channel.

High cost of marketing results from this multiple handling and lapses of time. The latter is important inasmuch as vegetable quality and, presumably, its price, hinge on its freshness . The longer the time lag between the farm and the consumer's kitchen, the lower will be the quality of product because of generally inadequate facilities for prolonging shelf life.

The after-effects of insufficient farm-to-market roads, coupled with inadequate facilities, would be a high degree of spoilage and shrinkage (5). Furthermore, this gives rise to the situation where small areas of surplus production suffer from the lack of outlets while there are big volume buyers, such as vegetable processing firms, who have to import raw materials for their operation.

Most processing firms in the Philippines have to import their raw materials due to the poor quality and inadequate supply of local products. For tomato paste alone the Philippines has to import at a cost about $ 1.5 million per year from the United States, Portugal, and Taiwan.

The Food Terminal, Inc.

The only major agency designed primarily to improve the distribution and marketing system for farm produced food product is the Food Terminal, Inc., a government agency. Among the programs being pursued by FTI to achieve its aims are the following (6):

a. Establishing trading posts all over the country as procurement bases from which FTI can draw the supply required in the major consuming areas.

b. Developing a more efficient food commodity flow system in order to narrow the price spread between farmers and consumers, notably through its marketing contracts with farmers and the initiation of the food train which brings in fruits and vegetables from production areas, particularly in Southern Luzon.

c. Through export assistance programs to encourage exports.

d. Assisting farmers in obtaining loans to facilitate production.

e. Establishing a commodity exchange center at the main FTI site.

Investment in Marketing Operations

In the private sector, it had been observed that vehicle acquisition comprised the major investment item among contract buyers, financier-wholesalers, and assembler-wholesalers. On the other hand, the retailers'

Table 6. Inventory of facilities used by middlemen in the Philippines.

Item	Average value of facilities		
	financier-wholesaler	assembler-wholesaler	retailer
	(US$)		
Building			
Packing	4,592[a]	120	
Storing shed/stall	4,660		90
Vehicles	1,661	1,700	
Tools and equipment			
Weighing scale	43	34	28
Wooden crates *Kaing*	1,065	20	2
Others[a]	19	27	4
Total	7,[illegible]7	1,768	12

[a]Onion only.
Source: Deomampo, N.P. and E.B. Torres, 1976. "An analysis of market intermediaries and their contribution in the distribution of selected agricultural products." Dept. of Ag. Econ., IADA with PCARR funding, Los Baños, Laguna, Philippines.

main investment consisted mainly of putting up stalls for storage and product display (7). Only among financier-wholesalers of onions was there a significant investment for storage purposes (Table 6).

Market Services

The services performed by middlemen are measured in terms of their contribution in the distribution of goods from growers to consumers. For vegetables, farm-level buyers merely assemble the products from numerous small growers. Financier-wholesalers perform more services such as trimming, packing, sorting, and transporting. In the case of storable products such as onion, storing is mainly done by financier-wholesalers.

Assembler-wholesalers consider crating and transporting as their major market obligations. They claim that they trim vegetables damaged during transit, which adds to their cost. Further trimming and sorting constitute most of the retailers' contribution. This clearly indicates the duplication of marketing services performed by the tiers of middlemen along the trade channel.

Grading is not generally done either by buyers or sellers. Sorting of products is largely a subjective process of classifying products into small, medium, large.

IMPLICATIONS FOR THE INDUSTRY

The recognition that the country is far from self-sufficient in vegetables to meet the nutritional requirement of the nation is evident from statistics. Expansion of cultivated area, which was the main source of increased production up to the 1960s, can no longer be depended upon to provide the needed supply. Research and extension on the technology to increase the productivity of agricultural resources are or will be the major pillars that we can depend on if we are to meet the food self-sufficiency objective of the country.

The national programs launched to extend scientific practices to farmers are aimed at bridging the gap between the experiment station and the farms. There are promising results from these programs. The next major problem will be distribution and marketing. It is ironic that while there are small farmers who cannot dispose of their products due to physical and institutional marketing barriers, almost all the large vegetable processing firms have to import raw materials to keep their processing plants operating, Furthermore, the export market for Philippine vegetables to places such as Japan is promising, if only the industry can be developed to supply it.

With these developments it should now be possible to think of research beyond a description of the problem at hand. If there is a sincere desire to help farmers, researchers should start analyzing the feedback from farmers to find solutions to their problems. This requires a more pragmatic research approach.

Research can be done at several levels to meet the national objectives. Aside from the data requirements of planners and decision-makers, the needs of producers and marketing people in general should be examined. For the latter, the task lies primarily in the area of what is known as auxiliary services in marketing such as improvements in packaging, transporting and storing. Research here needs to consider the fact that the Philippines has a hot and humid climate. There is a need for alternative practices that are capital intensive due to the limitation of resources among the farmers and product handlers in general.

Auxilliary marketing seminars are critical for the rationalization of marketing vegetables in the country. Quality of produce is important. No marketing schemes can work if one starts with poor quality produce or does not have the necessary services that lay the groundwork for an efficient marketing system. Hence, post-harvest practices are more critial than pricing schemes, buffer stocks, etc.

Take packaging as an example. For a long time the farmers have depended on bamboo baskets for most vegetables, with the exception of Food Terminal Inc., which has developed its own packaging design with the use of wood. There are many industries that also use bamboo as a raw material, such as the furniture and cottage industries. A time may come when bamboo is no longer as cheap for vegetable packaging. There are many competing users for it and there are not extensive new plantings to replenish the supply. Hence, alternative packaging materials need to be developed and tested, packaging designs that will lessen spoilage and damage to the products while in transit or storage. These may be small details but they have to taken care of to make a success of marketing plans.

Recent developments in the social setup should also be taken into consideration when studying marketing plans for the producer. The village

organization of pre-cooperatives in the barrios can help offset the difficulty of individual farmers in product disposal. The major research concern here would be in the reduction of marketing costs to individual producers. Farmer groups may provide a way to achieve economies of scale. Now marketing workers have to exercise caution in advising farmers to bring their produce to the market in order to get better returns, especially if they have inferior quality products and only a couple of baskets which must be transported over long distances. The farm may be better off selling at the farm gate under these circumstances. But if they can practice group marketing, costs to individual farmers may be reduced to the extent that it may be profitable for them to bring their produce to market.

The problems in marketing are complex and many while the solutions and recommendations that work are few and scarce. Because of the perishability of the product, area marketing schemes should be localized. Sometimes national programs are so highly aggregative that implementation at the local level is difficult. Perhaps, experiment stations in every region need not limit their technical personnel to the function of production specialists. Some attention is needed toward training personnel to conduct the economic and marketing studies required by the region. After all, production and marketing are like two scissor blades, one is useless without the other.

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DISCUSSION

Castro: You said that it is not economical anymore to grow vegetables in the highland because of transportation costs. And you recommend growing them on the lowlands. But is the quality of the product the same?

Torres: We have heat-tolerant cultivars that are suitable for lowland production. The yield may not be as high and the highland produce may bring in higher prices, but in terms of costs and returns, the farmers may still find it more profitable to grow vegetables in areas nearer the distribution outlets.

Tsou: Comparing your data on production and area in Table 5, is this by design or by accident?

Torres: The projected data are based on area expansion, assuming that present volume of production will hold. This only for the *Gulayan sa Kalusugan* program.

Rikken: How much does the government spend on the operations of the Food Terminal Incorporated?

Torres: About $13 million for operation alone. They have a storage area of 2.5 ha. Since SEARCA Director, J.D. Drilon, Jr., took over the management of FTI, its operations have been improved. The Development Bank of the Philippines provides the funds.

Rikken: Would you say that the farmer's losses due to poor packaging with bamboo materials are more tolerable than the expensive cost of wood crating designed for greater protection?

Torres: Our concern is to find other packaging materials besides bamboo. The cottage industry is utilizing much of the available bamboo as raw material for various products. There will come a time when bamboo will be too expensive. By then, we should be ready to recommend other packing materials.

Calkins: Judging by the data on average vegetable production by region, it seems there is unhealthy competition in the Philippines. Could you program the development of the vegetable industry by determining which region should concentrate on specific crops? In that way, extension efforts could be concentrated in specific areas and specific crops. Market information would be easier to channel and a functional producers association could be organized to deal with price mechanisms.

Isada: We have begun efforts in this direction in the Philippines. Our criteria for the selection of the production areas are accessibility to market, cost of production, yield, and frequency of typhoon.

Tomato is grown extensively in northern Mindanao when its cultivation is not feasible in Luzon. The average farm price last year was US$0.13/kg. Sometimes, it could go as high as US$0.26/kg and as low as US$0.9/kg. These are good prices for growers.

Then we have cabbage which has been traditionally grown in the highlands of Benguet. Now, we can grow cabbage in the lowlands with the use of heat-tolerant cultivars. The cost of production in the lowlands is

much lower, and for this reason we are trying to shift cabbage production to these areas. Tomato production during the rainy season is concentrated in areas away from the typhoon belt.

Tsou: What are the PCARR priorities for vegetable production?

Torres: (1) Varietal improvement, (2) production economics and marketing, (3) processing and utilization, (4) cultural management, and (5) sociology and extension research.

In terms of manpower, PCARR estimates that we need a total of 1104 MS and 828 Ph.D. holders to conduct the vegetable program planned for the next 5 years.

Castro: What incentives do you have to offer to retain all these people in their jobs? What is your guarantee that those you send on scholarship will not transfer to other organizations?

Isada: Scholarship grantees are required to sign a contract to serve their institution 2 to 3 years for every year they spend obtaining an advanced degree.

CONVENTIONAL AND NON-CONVENTIONAL VEGETABLE PROCESSING IN TAIWAN

Chin Fung Li[+]

A variety of vegetables and fruits are grown in Taiwan. Most fruits in Taiwan are produced in the summer, whereas most vegetables are grown during the winter (Figs. 1 and 2). This is due partly to the planting schedule but the main reason is the weather. Most of the vegetables and fruits are marketed as fresh produce and only a small portion of the produce is processed.

The total arable area in Taiwan is 917,111 ha, utilized as follows:

Paddy land	515,852 ha
Dryland	401,259 ha
Orchard	126,061 ha (31% of dryland field)
Vegetables	187,381 ha (36% of paddy field)

The above figures indicate that the paddy land is not sufficiently utilized for vegetable cultivation, Actually, more vegetables can be grown in winter after the second harvest of rice. This, however, is difficult to achieve due to the shortage of labor in the farm villages and the low price of vegetables.

CONVENTIONAL AND NON-CONVENTIONAL METHODS FOR PROCESSING VEGETABLES

Canning

In 1945, after World War II, only a few processing plants were operating at the rate of several thousand cases of canned pineapples. In 1951, efforts made by Joint Commission of Rural Reconstruction (JCRR) to introduce new species of pineapple resulted in a marked increase of production. In 1958 and 1963, respectively, Taiwan succeeded in cultivating mushrooms and asparagus and brought prosperity to the canning industry. Canned products have become the most important exported food products since then.

At present, there are 270 canneries in Taiwan and they exported canned foods in 1975 amounting to 14.3 million cases at a total value of US$25,200 million. Of these products, mushrooms, asparagus, and pineapples are the major commodities and are about 70% of all canned foods. The production of mushroom was 48,802 t in 1975 and that of asparagus, 80,113

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Fig. 1. Major vegetables time of production and processing methods in Taiwan.

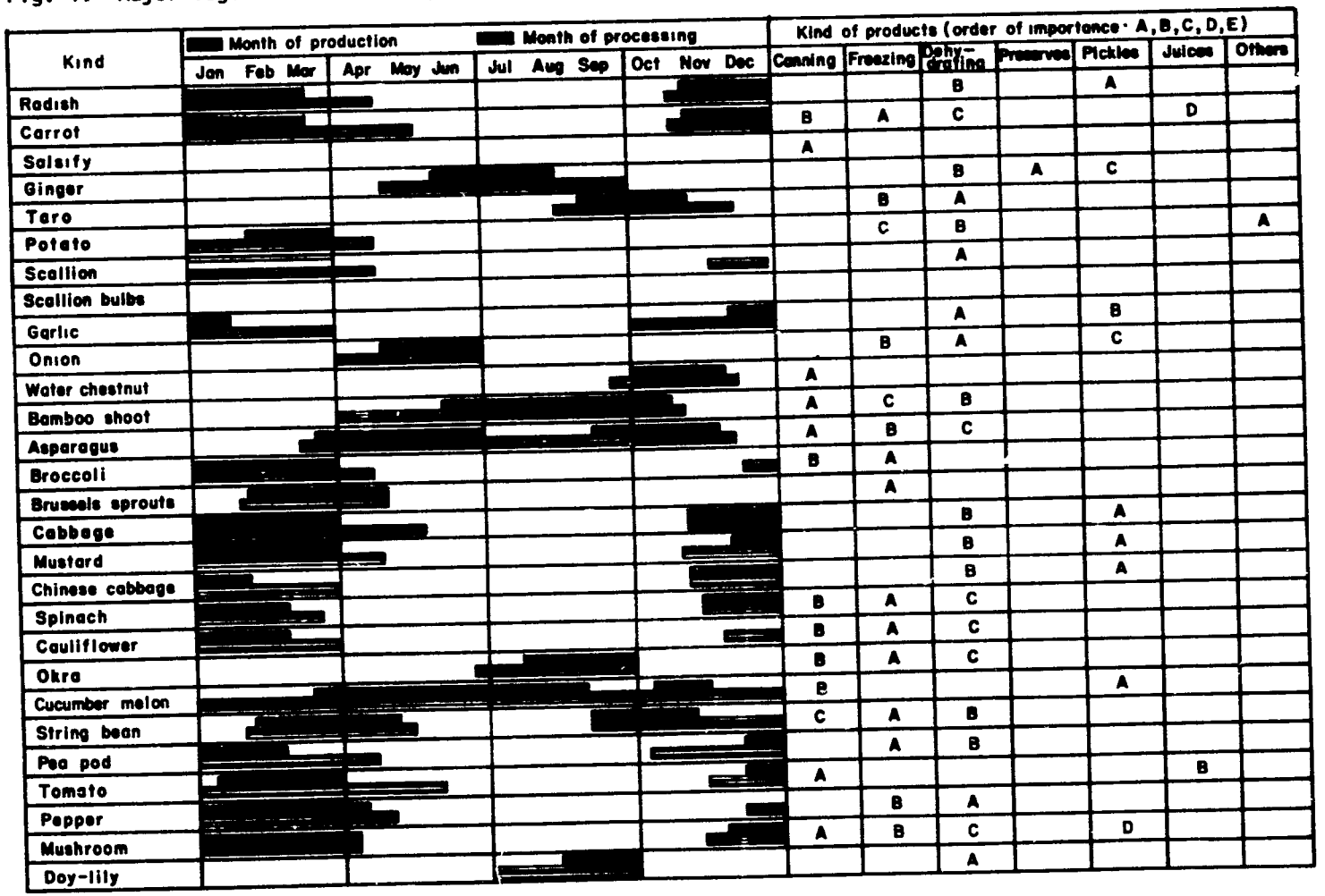

Fig. 2. Major fruits time of production and processing methods in Taiwan.

Kind	Month of production						Month of processing						Kind of products (order of importance A,B,C,D,E)						
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Canning	Freezing	Dehy-drating	Preserves	Pickles	Juices	Others
Pineapple													A	B	C	D		E	
Tankan													A			C		B	
Sekkan																B		A	
Tangerine													A					B	
Valencia																B		A	
Golden seal orange																		A	
Lemon																		A	
Kumquart																A		B	
Leechee													A	C	B				
Longan													A		B	C			
Bengo													B	C		D		A	
Guava															B			A	
Papaya													C			A		B	
Grape													C		D	B		A	
Carambola													B			A		C	
Olive																B	A		
Passion fruit																		A	
Loquat													A			B			
Peach													A	B		D		C	
Prune													E		C	A		B	
Plum															C	B		D	
Pear													A	C				B	
Apple													D		C	A		B	
Chestnut													B		A				
Persimmon															A				
Banana															B				

t. Other canned foods produced in Taiwan are tomato (paste, puree, juice, and sauce), oranges (segments and juice), bamboo shoots, other fruits, water chestnut, marine products, and meat products.

Many kinds of fungi other than mushroom (*Agaricaceae*) such as oyster mushroom, straw mushroom, golden mushroom, and wood ear (*Auriculariaceae*) are also cultivated in Taiwan, and processed by canning, freezing, or dehydration.

Most of the canning plants are well equipped and practice quality control. Attempts are being made by the government to encourage small plants to unite together so that the capacity and efficiency of processing equipment can be improved and the quality of products can be improved.

Freezing

Preservation by freezing, which was initiated in the 1960s, is still in its infant stage in Taiwan, although considerable progress has been attained. The total value of frozen foods produced has increased from US$80 million in 1974 to US$130 million in 1975.

Most of the forzen foods produced in Taiwan are exported and the domestic sector consumes only a small protion of the produce. The reason for this is that supermarkets exist only in the larger cities and the price is also much higher than that of the fresh foods.

Frozen vegetables in Taiwan include mushrooms, asparagus, pea pods, spinach, and broccoli. Pineapple and other fruits are also frozen.

The freezing methods usually employed in Taiwan plants are I.Q.F.,+ air blast, liquid nitrogen, and freon 12 freezing. The older freezing plants use the air blast method and newly built plants are mostly using I.Q.F. Only a few plants use the liquid nitrogen freezing method.

In comparison to canning, freezing facilities and operations entail larger capacities, bigger investment, and higher operating cost.

Dehydration

It was an old fashioned practice among housewives to dry vegetables in the sun during the season when the price was lowest and store them for off-season or typhoon period when the price was high. There are many small plants in Taiwan producing dehydrated vegetables and fruits using simple tunnel dryer, pan frier, or even the simplest oven.

Fluidized bed dryers designed by the Food Industry Research and Development Institute are also used in several plants to produce dehydrated products such as garlic, green onion, and ginger. Fluidized bed drying was developed in Taiwan several years ago. Products produced by this method have good quality and cost less.

There are also 2 to 3 plants which employ freeze drying to produce dehydrated mushrooms, asparagus, green onion, beans, and carrots. Although it is well known that freeze drying creates high quality product, the method is very expensive and suitable only for products with high

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+I.Q.F. means "individual quick freezing."

commercial value. Almost all of the freeze dried products produced in Taiwan are exported.

The total value of dehydrated foods produced in 1974 was US$100 million. Most of the products are exported and the domestic consumption is almost exclusively used in instant noodles as seasoning or additive.

Preserves and Pickles

Many kinds of fruit are grown in Taiwan. Fruit preserves are very popular and their processes and methods of preparation have long existed and have become one of the most important businesses in fruit processing. The most popular preserves are made from plum, prune, carambola, kumquat, papaya, pineapple, mango, and ginger.

Most of the plants producing preserves are very small in capacity and still use the sun drying method. Two or three plants employ a modern drying process to produce new types of preserves.

There are many traditional methods for processing salted vegetables and pickles in Taiwan, which were derived from mainland China in the early days of settlement. Before World War II, when the Japanese occupied Taiwan, Japanese methods for processing salted vegetables and pickles were also studied. Salted vegetables and pickles are used as subsidiary foods both at home and in restaruants. It is estimated that at least 90% of the Chinese people eat these products every week.

Among pickles, the most important products are pickled cucumbers and pickled melons (wax gourds, *Benineasa hispid*) which are prepared by curing and then seasoning in soy sauce or by curing in soy sauce mustard. These are classified into two groups, depending on the processing methods employed. Crisp pickled cucumbers are prepared by curing and then immersing cucumbers in boiling soy sauce to inactivate the enzyme activity, whereas soft pickled melons are prepared by curing and then immersing them in fresh soy sauce to let the enzyme soften the melon tissues. These products are produced in large quantities and most of them are packed in cans.

Other traditional pickles are salted mustard(*fu-tsai*),sour-hot mustard (*tong-tsai*), Chinese sauerkraut, pressed mustard, and salted radishes.

Pickles derived from the Japanese such as Fu-shen tsai (*Fukushin Zuke*) and pickled yellow radishes (*Takuan*) are also produced in Taiwan.

Vegetable Juices

Many kinds of bottled and canned juices are produced in Taiwan. They are pineapple, orange, mango, guava, grape, passion fruit, and mixed fruit juice. Asparagus juice and mixed vegetable and fruit juice are beverages that have been developed in Taiwan which cannot be found in other countries.

Asparagus juice is the extract of asparagus stalks which are unsuitable for canning or the cuts and trimmings rejected during the canning process. Water, sugar, and flavoring are added. It has become the most popular juice in the domestic market.

Mixed vegetable and fruit juice is prepared by mixing the juices of celery, carrot, spinach, cabbage, tomato, pineapple, orange, asparagus,

and lemon and adding sweetening. The domestic consumption of mixed vegetable and fruit juice is increasing.

Tomato juice, puree, and paste have attained popularity among producers for the past several years. Production in the farm and in processing plants is increasing every year, but most of the products are exported because local consumption is low.

Soymilk, a traditional beverage among the Chinese, is widely consumed. This product is now produced on a large scale using the most advanced technology. Usually, soymilk is sweetened, flavored, and packed in bottles or bags.

Mixed vegetable juice similar to V-8 was produced on a trial basis by one of the plants in Taiwan several years ago. This product failed to be accepted by consumers in a market test and its production was discontinued.

Soy Protein-Lipid Film (Yuba)

Yuba is a popular foodstuff in the orient, especially in China. It can be consumed directly as an ingredient of soups or used as a sheet for wrapping and shaping ground meats or vegetables.
Dishes of vegetable chicken and vegetable ham are commonly prepared from this kind of protein-lipid film. Traditionally, yuba is made by heating soymilk in shallow pans over a low fire until a surface skin is formed on the pan. This skin is lifted off periodically with sticks and then air dried on racks. This process is laborious and the product is uneven both in chemical composition and physical properities.

An automatic and continuous method for processing yuba has been developed by the Food Industries Research and Development Institution (FIRDI). In this process, sodium alginate at the level of 0.6% is added to soymilk containing 8 to 10% solid content. After mixing and de-aerating, the mixture is pumped into a trough flowing with 5% calcium chloride solution and coagulated to form a thin film immediately. This film is then tranferred to a rinsing trough to wash off calcium chloride incorporated into the film, which could produce a bitter taste. Finally the film is dried to decrease water content from about 90 to 50% of that in traditionally made yuba.

Sodium alginate is expensive and the yuba made by this process needs washing and drying. Another new process employing a drum dryer is being developed in FIRDI. Results obtained from preliminary experiments indicate that this new process is promising. Experiments on the new process are still in progress.

CONCLUSIONS

Although vegetable processing in Taiwan is already well-established there are still some problems that need to be solved.

First, the prices of vegetables are not very stable. When prices are too low, the farmers suffer. On the other hand, when the price is too high, the processors find it difficult to operate at profitable levels. To maintain a reasonable price, supply and demand must be balanced by good planing and correct estimation prior to planting; otherwise, overproduction and under-production will continually be harmful to either farmers or processors.

Second, growing vegetables in Taiwan utilizes a large labor force and labor costs are rising. Mechanical planting and harvesting would be economically impossible because the farmland is too small. To decrease the growing cost, we need to reform and increase the scale of our farmland.

Third, more efforts should be made to improve the existing species or introduce new species of vegetables, expecially those suitable for processing.

Fourth, to obtain adequate raw material for processing and to stabilize the price, it is better for processors to purchase raw material by contracts instead of purchasing from free markets. This may be beneficial to both farmers and processors in the long run.

Finally, the research and development of new products should be emphasized and encouraged. It is hoped that vegetable industry information and techniques will be exchanged internationally for the prosperity of all Asian countries.

DISCUSSION

Rikken: What can developing countries learn from Taiwan's experience? What are the appropriate techniques that can be adopted by developing countries to develop vegetable production, especially marketing and processing? With a highly mechanized system of processing, won't you be displacing labor which is abundant in all developing countries in Asia?

Li: It is difficult to answer your question, but FIRDI is willing to help any country as it is a non-profit institute. But now the Republic of China doesn't have diplomatic relations with many Asian countries.

Calkins: Fortunately for Taiwan, the seasons for processing vegetables and fruits are complementary. Thus, there are less seasonal problems for the processing industry. The capital investment for processing may be high but industry is assured of a stable processing schedule with minor fluctuations. Moreover, conventional types of Chinese processing methods could serve as an intermediate type of technology for other countries in the region desiring to employ more labor. You saw in the slides that even with mechanization, considerable manual labor may still be utilized.

Senanayake: Some of the processed products that you described use labor intensive methods. What proportion would be the cost of labor to the entire cost of producing these products?

Li: I don't have the exact figures; packaging materials are imported so they cost a lot. Labor cost would be about 20% of the production cost.

The most important industry in Taiwan is the canning industry. Most of the products are exported. However, markets can't be controlled. This is the most important problem. Most of the products are vegetables.

Pandey: Do you have any ideas on the use of cow dung or buffalo dung for mushroom culture?

Li: In Taiwan we can produce artificial manure. We have very few horses in Taiwan, but I think you can use buffalo dung too.

Moomaw: The use of horse manure is traditional for growing mushrooms. But they make use of substitutes because of the shortage of manure. They also developed a mushroom house made of bamboo, plastic (PE films), and rice straw. Artificial horse manure was also developed making use of composted rice straw, fertilizer, soil, and other compostable materials.

Anothai: If you grow straw mushrooms, you will need straw. Also, you can use artificial manure, sawdust, and kapok waste for other kinds of mushrooms.

Li: We also grow straw mushrooms on waste material from the cotton industry.

Pritana: From the slides, it can be said that your country is advanced in vegetable production. I am interested in bamboo shoots. Is that crop grown commerically or is it left to grow wild?

Li: We have a few large scale bamboo fields, but the sprouts are mostly produced on a small scale (backyard garden).

Pritana: Is it seasonal?

Li: Production is seasonal. Most of the shoots are harvested during the summer and only one or two varieties are harvested in winter.

Calkins: I have visited cassava and sweet potato starch factories in Taiwan. During the summer when there is no raw material for starch production, these factories often process bamboo shoots. They are packed whole in cans so that restaurants and foreign users can cut them any way they desire.

Pritana: In what area of Taiwan can the best artichoke be grown?

Li: I don't know. Maybe the northern part or the highland.

Anothai: Artichoke is a perennial crop. It is grown in cool weather. A technique has been developed to induce flowering.

de Padua: Vegetables are usually grown away from consumption areas. Your paper did not cover problems of packaging, handling, and transporting which are quite serious in many countries.

Li: In Taiwan, most of the vegetables are consumed in fresh form. And we really don't have problems of handling although the cost of packaging is expensive. Taiwan is a very small island, and we have little transportation problems.

Castro: You might wonder where all the vegetables go. Markets have collection points and there are central markets, too. Activities are continuous from Monday to Sunday, day and night.

de Padua: How are vegetables brought to the urban centers without affecting their freshness?

Tsou: Taiwan is a very small country. It only takes 6 hours to travel from north to south.

Torres: You said there are 270 processing firms in Taiwan. Where are they located?

Li: Near the farms, in the middle and southern part of Taiwan.

Castro: Time lag is not a problem in Taiwan. They even have a system of announcing prices to farmers' organizations so the farmers know what time to harvest to take advantage of the high price.

Anothai: The method of packing has to be researched further.

Senanayake: Since capital intensive processing methods are used in Taiwan, and the processing capacity has increased, have prices been stabilized by the development of processing methods as a result?

Li: Packing materials are costly in Taiwan.

Li: Government organizations decide the price for mushroom and asparagus. The price of canned food is quite stable.

Calkins: In the case of fresh produce, on the other hand, there is price fluctuation because of consumers' preferences, appearance, and other variable factors.

Yang: What do you call the protein film material?

Li: Yuba. It is a Japanese word. It means this food can be eaten after reconstitution in hot water.

Bautista: Are leafy vegetables processed because of over-production or are they raised mainly for processing.

Li: They are produced in a small-scale level mostly for fresh consumption so as not to affect the price.

Torres: How do you determine the price of vegetable products, particularly for processing?

Li: There are special organizations to determine prices.

Torres: In the Philippines, processors offer residual prices, subtracting costs of processing and transportation. This is not a good incentive for farmers.

Tsou: This is where farmers' organizations would play an important role.

Calkins: The problem in the Philippines seems to be that the market channel is too long. Processing firms in Taiwan have special extension agents who do not belong to the government system. They help farmers technically. Moreover, price is based on a partial incentive basis so that the farmer is induced to produce high quality output. The area planted to tomato in Taiwan has increased several fold in the past 5 years as a result.

Torres: In the Philippines, only the Food Terminal, Inc. has facilities and resources for contract farm growing.

Castro: In Taiwan, all aspects of production and distribution are planned ahead; even prices are determined.

Anothal: Regarding contract growing, the farmers must have a certain degree of loyalty. This loyalty is inherent in the Chinese, Japanese, and Koreans, but this is a trait that we still have to develop in other countries. It is easy to plan on anything else if the people have this sense of loyalty.

VEGETABLE PRODUCTION IN SRI LANKA

Y.D.A. Senanayake[a]

A wide variety of vegetables ranging from tropical to temperate types are grown in Sri Lanka throughout the year. The most common types are listed in Table 1. Sri Lanka has always been self sufficient in vegetables primarily because of the constant supply of a variety of fresh vegetables to choose from and the predominance of different climatic conditions within the country that have been exploited successfully to produce the country's requirements.

A local distinction is made in respect to a few vegetables that are listed in table 1. Chilies in both the mature green and the ripe dry forms, onions, and garlic are considered as *condiments*. Also, the different forms of dry legumes such as dhal, lentils, mungbean, and cowpea which are prepared often as vegetable dishes are grouped as *pulses*. The condiments and pulses together with white potato and some of the root crops such as sweet potato, manioc, and yams are commonly referred to as *field crops* in production planning and development programs.

Table 1. Classification of vegetable groups commonly marketed in Sri Lanka.

Leafy	Root-tuber (cont'd)	Fruit (cont'd)
Cabbage	Sweet potato++	Winged bean
Gotukola+	Yam ++	Watakolu+
Kankum+		
Kohila+ leaves	Fruit	Flower
Leek	Ash plantain	Cauliflower
Lettuce	Ash pumpkin	Kathurumurunga+
Mukunuwene+	Bean	Condiment++
Spring onion	Bitter gourd	Chili
Thampala+	Bottle gourd	Garlic
	Breadfruit	Onion (small)
Root-Tuber	Brinjal+	Onion (large)
Beet	Cucumber	
Carrot	Drumstick+	Pulses
Kohila yam+	Long bean	Dhal and Lentil
Manioc++	Okra	Mungbean
Innala+	Pea	Black gram
Knol Khol	Red pumpkin	
Potato++	Snake gourd	
Radish	Tomato	

+Local name. ++consider a field crop in Sri Lanka.

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The condiments and pulses were imported at great cost until the government banned their importation four years ago, in order to boost local production and achieve self-sufficiency. Importation of potatoes had been banned earlier for the same purpose. This policy has brought about the desired result and judging from recent production data, the output of these crops has increased to meet the local demand. Their prices, although high at the moment, are expected to stabilize at lower levels with greater productivity in years ahead.

INFLUENCE OF CLIMATE

Though Sri Lanka lies between 6° and 10° north of the equator, its climate is moderate compared to most countries in the equatorial belt. Because it is surrounded by the Indian Ocean, the rainfall rhythm is determined by the northeast and southwest monsoons, depressions, and convections. The distribution of rainfall is not uniform. It depends on the monsoonal winds. The two major cultivation seasons are dependent on the southwest monsoon which brings rain during the May to September *Yala* season to the southwest quarter of the island and the northeast monsoons which blow during the November to January *Maha* season bringing rain to all parts of the country.

Apart from the variation in rainfall, differences in temperature are also found. These differences are primarily influenced by altitude, since within a distance of about 115 km by air or 180 km by road from Colombo, the capital city of Sri Lanka, the land mass rises from sea level to 3000 m. Other factors such as rainfall, cloudiness, and oceanic breeze also have a moderating effect on the temperature in the lowlands.

Differences in altitude and rainfall demarcate the country in to seven broad agroclimatic zones (Figure 1 and Table 2).

In the past, vegetable production was divided into two years. The

Table 2. Agroclomatic zones and their characteristics in Sri Lanka.

Zone	Region	Elvation(m)	Average temperature(°C)	Rainfall(mm)
1. Lowland wet (LW)	Southwest	<350	± 25	2000-5000
2. Lowland dry (LD)	Northeast, east, & southeast	<350	± 28+	900-1500
3. Midland wet (MW)	Central-west	350-1000	20-22	2000-3000
4. Midland dry (MD)	Central-east	350-1000	20-24	1200-1750
5. Midland intermediate (MI)	Central-east & Central north	350-500	20-24	1500-2000
6. Highland wet (HW)	Central	1000-2000	10-18	2000-5500
7. Highland intermediate (HI)	Central-east	1000-1500	15-22	1500-2250

+Could reach 35-40°C from June-Sept.

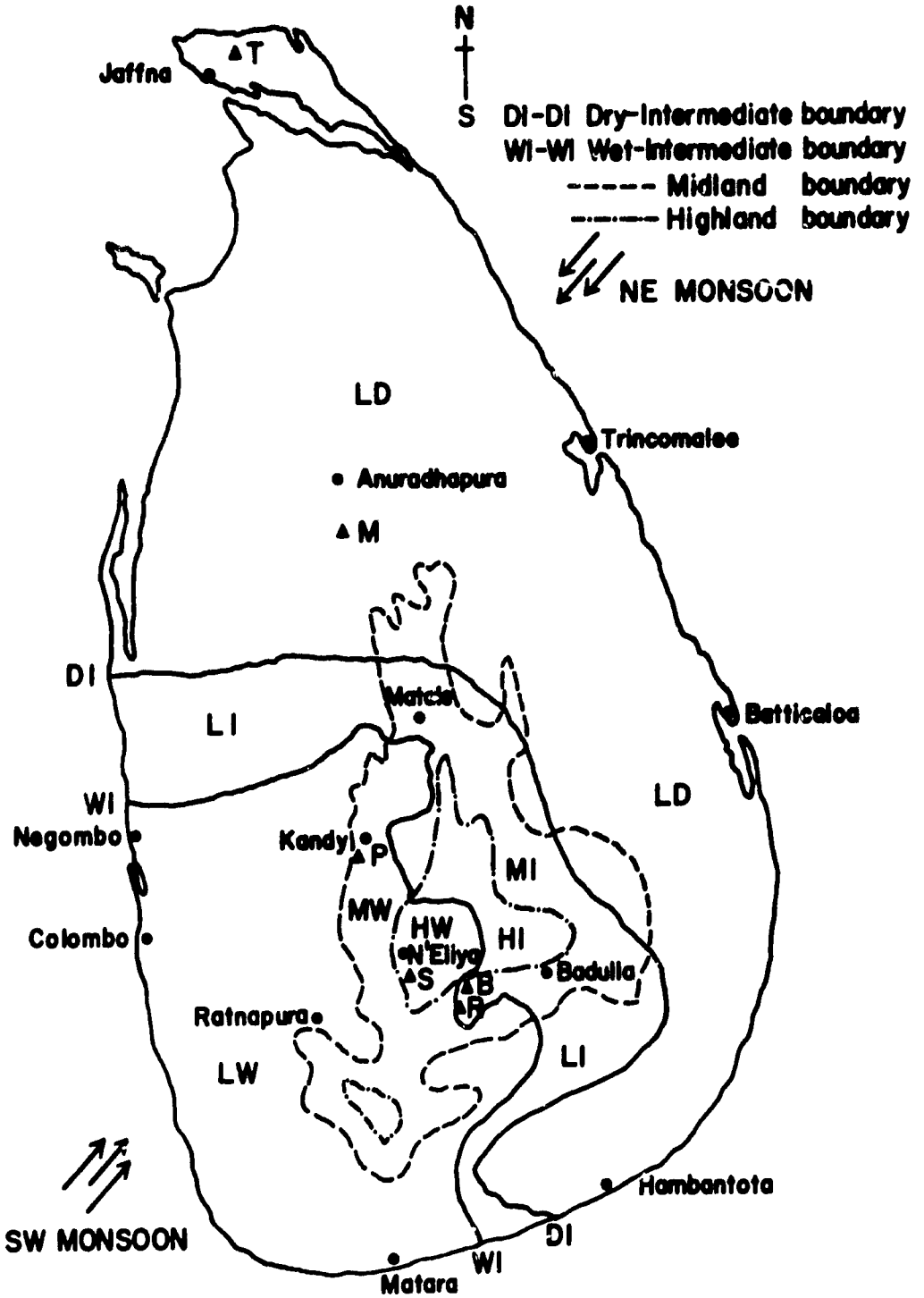

Figure 1. Agroclimatic regions in Sri Lanka.

cool temperature types were cultivated throughout the year in the cooler highlands and midlands. The tropical forms were cultivated seasonally in the warmer midlands and lowlands. In recent years, this dichotomy appears to be breaking down. Some varieties formerly grown only in the temperate zone are being grown in the warm midlands and lowlands during the *Maha* season. The temperature is slightly lower in the *Maha* season than in the other months due to cloudiness and rain. The expansion of cultivations to lower elevations was caused by shortage of suitable land in the highlands for expansion. Most of the land in this region is under tea cultivation. The high income potato crop also competes for the available vegetable land in the highlands. Development of new varieties adapted to warmer growth conditions aided the shift away from traditional growing areas.

The tropical types of vegetables are still confined to the warm midland and lowland areas. They are cultivated in both seasons in the wet zone and principally in the *Maha* season in the dry zone. Among the condiment group, green chilies are cultivated in the wet and dry zones, as a rainfed crop whereas dry chili production is predominantly concentrated in the dry zone as a rainfed crop in *Maha* and as an irrigated crop during *Yala*. Pulses and onions produce best in the warm, dry lowlands in the *Yala* season under irrigation.

Consumption Patterns and Expenditure

A detailed socioeconomic survey which was conducted in Sri Lanka in 1970 revealed that the average household expenditure per month on food was 55% of the total expenditure (1). Among the three major categories of population groups surveyed, urban, rural, and estate or plantation, the average expenditures were 48, 56, and 59%, respectively. The national average expenditure on vegetables per household was 17% of the total expenditure on food, goods, and services. Among the urban, rural, and estate sectors, the corresponding values were 15, 16, and 18% of the expenditure on food or 8, 10, and 12% of the total household expenditure.

The national per capita consumption of vegetables per year was 12¢/kg. The corresponding values for the urban, rural and estate sectors were approximately 70, 73, and 77 kg at a cost of 13, 12, and 11¢/kg, respectively (Table 3). The urban sector has consumed less vegetables, not due to unavailability but due to their higher unit cost. Differences in the quantities of different categories of vegetables consumed by the three sectors are presented in the table. Detailed information on consumption and expenditure for the individual vegetables in each category is available from the results of this survey. Information of this nature also is available for six different monthly income groups in the population ranging from the group that earned less than $24 to more than $120/month. Such information is valuable in planning the amounts of different types of vegetables required for different sectors of the population.

On the basis of the consumption pattern in 1970, the amount of vegetables consumed that year would have been 880,000 t. If condiment and pulses are excluded, the amount of fresh vegetables consumed would amount of 690,000 t. Allowing for marketing losses, 1,000,000 t of all vegetables or 780,000 t of fresh vegetables would have been required that year. To meet the requirements of an increasing population, an additional 20,000 to 25,000 t of all vegetables or 16,000 to 20,000 t of fresh vegetables would be required each year to maintain local consumption at the 1970 levels. The additional requirements pose challenging problems not only

Table 3. Per capita consumption of vegetables per month in Sri Lanka.

Category	Per capita consumption per sector							
	national		urban		rural		Estate	
	quantity	value	quantity	value	quantity	value	quantity	value
	(kg)	(US¢)	(kg)	(US¢)	(kg)	(US¢)	(kg)	(us¢)
Leafy vegetables	1.27	7	1.70	9	1.22	6	0.99	6
Root/bulb/tuber	0.94	8	0.68	9	1.05	9	0.61	6
Fruits	1.94	20	1.67	22	2.03	20	1.80	17
Condiments	1.05	25	1.21	27	1.01	23	2.00	26
Pulses	0.46	9	0.40	8	0.44	8	0.80	17
Others	0.29	2	0.19	2	0.33	3	0.21	2
Total	5.95	70	5.85	76	6.08	70	6.41	73
Per capita/yr	71.40		70.20		72.96		76.92	
Cost/kg		12		13		12		11

for planning production, but also in transporting, storing,and marketing the produce.

Systems of Production

Vegetable production in Sri Lanka varies from single cropping to different degrees of multiple cropping. The highest cropping intensity is in the cool highlands of the Nuwara Eliya district where arable land is scarce but the climate is favorable throughout the year. The technology of production in this region is adequte, land use is intensive, farmers are competent, and the marketing of inputs and produce is organized. A comparable system prevails in the green leafy vegetable market gardens, *Keera* gardens of Colombo.

Going beyond Nuwara Eliya to production areas in the surrounding midlands of the Badulla, Kandy, Matale, and Ratnapura districts, variability in production could be recognized. The extent of variation is determined by the location. As a result of climatic variation and production variables, such as poorer infrastructure, marketing, and land use when compared with conditions in the Nuwara Eliya district, there is less pressure on the land and the cropping intensity is lower too (2,3).

In areas where rainfall is intermediate, annual rotation of vegetable cultivation with paddy production during *Yala* and *Maha* seasons is a common practice. Moving out further to the lowland, the technology of vegetable production is poorest with exceptions in the Jaffna peninsula, located in the northernmost part of the country. The bulk of the lowland produtcion is during the *Maha* season when *Chenas*+, village gardens, and highland plots are used for rainfed vegetable cultivation with little supplementary irrigation, if any.

+*Chena* cultivation is the local term for shifting cultivation in forest clearings as practiced in tropical countries.

A recent development in the dry zone is the modification of the *Chena* cultivation concept where new forest plantings are allowed to be intercropped with vegetables for the first three years by villagers in a system called *Chena* reforestation or cooperative reforestation. In this system the villager adopts the same procedure as if he were raising a *chena* crop but, with the sowing or transplanting of his crops, he is expected to plant teak at a recommended spacing. When the *chena* cultivator moves to a new area after a few years he leaves behind a forest planting of far greater potential value than the jungle he had cleared.

As an inducement, the lessees are allowed to remove any timber not required by the State Timber Corporation upon the payment of a nominal amount as royalty. Furthermore, the lessee is paid a cash reward up to $27/ha if he carries out certain obligations such as clearing, burning, planting of teak, and looking after it for the three years. The teak seedlings are supplied at no cost by the Forest Department. It is expected that the system will reduce the extent of jungle clearing for shifting cultivation and at the same time contribute to the production of an additional 1000 t of fresh vegetables annually (5). The system could also be adopted for intercropping, new plantings, and replantings of other perennial crops like rubber, coconut, and different species of fruits.

MARKETING

There are three facets of marketing: seed requirements, input needs, and disposal of the marketable vegetables. The exotic seeds are imported only by the Department of Agriculture. This practice was introduced in 1963-1964 due to foreign exchange difficulties and marketing malpractices committed by several private importers. Centralization of imports allowed the government to obtain specified varieties of good quality seed from the cheapest source. During the first year of its operation, the price of imported seed sold to vegetable farmers was reduced 50% (6). The government introduced a controlled system of marketing the seeds to ensure that the farmers would receive the seeds in time at the most reasonable prices.

Seed requirements for 1978 will be based on the imports of 1976, the last year for which tabulated records will be available for evaluation before the orders are prepared. Uaually a 10% increase in supplies is estimated. Having considered records of the monthly viability tests and the viability data of March this year, quotations are requested for specified supplies from reputable suppliers by October. The successful tenderers are required to execute their orders by March 1978. The seeds are tested at Sita Eliya (S in Figure 1) as soon as they arrive and the results are used for claims against poor supplies and also to revise the standing of the suppliers.

Seeds are not issued to farmers during March. That month is used for testing the imported seeds and the stocks remaining from previous orders, and inventorying the stock of good seeds which are available for distribution during the rest of the year. All imported seeds as well as locally produced seeds are stored at Sita Eliya which is situated at an elevation of 2000 m where the cool atmosphere helps to maintain seed quality.

To ensure a fair system of seed distribution in the five principal vegetable growing districts, Badulla, Kandy, Matale, Nuwara Eliya, and Ratnapura, the requirements of the growers are determined by the District

Agricultural Extension Officer (DAEO) in close consultation with the Agricultural Productivity Committees (APC) and growers' cooperatives (COOP). The DAEO then tabulates the requirements of different varieties of seeds of each organization and forwards them to the central office of the Department of Agriculture where they are checked before they are forwarded to a cooperative marketing organization called Sri Lanka Cooperative Marketing Federation (MARKFED). This organization is the principal distributor of all imported seeds. Its function was performed before 1973 by Multipurpose Cooperative Societies (MPCS). MARKFED supplies the seeds to the APCs or COOPs directly or through other cooperatives either for payment or on credit. The pricing of imported seeds is made as follows.

Price= CIF value + 65% FEECS tax + 20% departmental charges

6% kept by the Department of Agriculture for transport and storage.

14% discount to MARKFED

4% kept by MARKFED

10% discount to APC, COOP, MPCS

Seeds of local varieties are produced in 15 production farms of the Department of Agriculture. Each year a 50% increase in production is targeted due to the high demand by numerous farmers and home gardeners. The tested seeds are stored at Sita Eliya where bulk orders are executed to APCs and COOPs through MARKFED. All small seed packets of 7, 14, 28 g required by home gardeners, small scale growers, and other producers are prepared and issued from Peradeniya (P in Figure 1) out of seed obtained in bulk from the central stores at Sita Eliya.

These packets are sold to customers directly or through the DAEO. About 70% of local seed is marketed in small packets. Local seed is priced at 20% above the farm production costs to cover costs of transport, handling, and packing. It is estimated that 30% of the seeds of local varieties used are the farmers' own seeds and the proportion is even higher for beans.

The consumers in the principal urban centers are supplied through three marketing channels: (1) the Marketing Department which is a government organization, (2) producer cooperatives or service cooperatives, and (3) the private sector. The private sector obtains its supplies through commission agents.

A recent development in this activity is the increasing role of MARKFED to purchase vegetables from producers at competitive prices and retail them to consumers at fair prices. During the first year of its operation in 1974, its collecting centers supplied 1216 t of vegetables. During the first 10 months of 1976 the supplies have increased to 3000 t. There is no doubt that its marketing activities will increasingly influence the price of vegetables in the local markets.

Vegetable prices fluctuate during the year based on supply. Prices are highest during the months of May and November which are the beginning of the two major cultivation seasons. Prices come down in August and again in January to February when the bulk of production from *Yala* and *Maha* seasons, respectively, enters the marketing channels.

STRATEGIES FOR THE FUTURE

Increasing Production

The prices of fresh vegetables have increased steeply during the last two years. It could be due to a multiplicity of causes such as unusually dry weather in most producing areas, less use of fertilizers and agrochemicals, use of older varieties and increases in transport costs. It is apparent that the increased quantities of fresh vegetables required to maintain consumption levels in the 1970s are not reaching the market. A concerted effort has to be made to maintain supplies at reasonable costs.

It was mentioned earlier that land for vegetable cultivation in the principal producing districts is limited due to competition from plantation crops, principally tea. But this condition could be altered by far-reaching land reform measures implemented by the government during the last three years. A large area of plantation land in districts best suited for vegetable cultivation is now owned by the government. While much of this land will be used for replanting traditional plantation crops, an extensive area is being distributed for different types of settlements on which mixed farming, including vegetable production, could be attempted. Likewise, the plantation sector could be required to cultivate part of the unused or underutilized land with vegetables by using excess estate and village labor. Thus, the restrictive factor of limited land resources in the midland and highland areas could be removed to a great extent in planning for increased production in the future.

Associated with this development is the more refined interpretation of agro-ecological data of the country which is being done by the Land Use Division of the Department of Agriculture. The use of this data should help to increase future crop productivity. Studies on soil water conservation and the development of catchment irrigation systems in the midland and highland areas where distribution of rainfall is below expectation awaits scientific investigation.

Varietal Evaluation

For the last 15 years or more, there has been little change in the vegetable varieties used by farmers. A preoccupation in planning for the improvement of output of cereals principally rice, has led to the neglect of vegetables. More staff and resources are needed to improve the performance of local vegetable types and evaluate foreign introductions. Thus, no improvement has come about in yield potential by the infusion of new germplasm. Breeding attempts, if any, have been sporadic without a long-term plan for varietal improvement. This vital area of research cannot be neglected any longer. With respect to exotic vegetables, an extensive program to evaluate new introductions was made during 1971 to 1975 with the assistance of the Federal Government of West Germany (7). Some 1100 varieties of 35 different kinds of vegetables from 8 families were introduced from Africa, Asia, Australia, Europe, and North America. These were evaluated in observational and screening plots, followed by replicated field trials of the more promising ones at 6 locations (B, M, P, R, S, and T in Figure 1) which represent the climatic conditions of principal producing areas. The trials gave useful information on new varieties which have higher yield potentials in comparison to traditional varieties. Their use would help to boost the output of vegetables from the existing area under production.

Cropping System

Reference was made earlier to intensive cropping systems in the wet highlands around Nuwara Eliya, brought about by the desire to maximize land use. Through the years, the farmers have developed crop combinations and cropping sequences that give high productivity. Trials on intensive systems of production and better land use with vegetables are now needed in areas where cropping intensity is low and where land will be diversified from existing patterns.

Many parts of the principal production districts are wet. Loss of nutrients due to leaching is a drain on the expensive fertilizer input. Studies on the use of slow release fertilizers and ways to improve efficiency of fertilizer use by crop combinations are needed.

Seed Production

Attempts at producing seeds of exotic vegetables in Sri Lanka have not been successful. The absence of cold field conditions for a required period prevents plants from flowering. The possibility of using cold storage treatments to induce flowering has been demonstrated recently (8). But its commercial application has not been thoroughly investigated.

An exception to the non-flowering was discovered recently when an open pollinated variety of cabbage from Taiwan called Early Yehsen was found to flower in some localities. In addition to imported seed of other cabbage varieties, locally produced early Yehsen seed is now made available to farmers. Thus, one simple solution to the seed production constraint may lie in the selection of cultivars that have low cold induction requirements for flowering.

Studies are also needed to identify the technology most suitable to increase the production of local varieties of seeds. At the same time, the development of cheap home garden vegetable packs that will keep the seeds in good condition for longer periods under tropical conditions would benefit the production effort.

Marketing

Marketing poses several problems. The most serious is the estimated loss of 20 to 30% of the marketable fresh vegetables. Poor handling from the time of harvest until the produce reaches the consumer, improper packing and poor stacking in vehicles are the principal causes. Shortage of vehicles to transport products and higher operational costs have forced the transporters to carry a much heavier load than normal, resulting in considerable damage to the produce.

Added to these problems is the congestion at the principal wholesale markets in Colombo and Kandy, which contributes to bad handling on the wholesale floors. The congestion also delays the movement of incoming loads, thereby contributing to rapid deterioration under warm conditions. All of the above increase the consumer price of the vegetables.

A recent study on cabbage, bean, and leek has revealed that the total expenditure for wholesale marketing services increased the consumers' price from 14 to 16%. During retailing, the marketing costs are increased by an additional 8 to 14% (9). Many suggestions have been made to reduce

marketing losses, but many difficulties have defied remedial measures. The development of a feasible plan to reduce losses would make more vegetables available and help reduce the price inflation that consumer has to pay.

Income Levels

Income from the cultivation of vegetables and fruits compares poorly with that from other agricultural activities (Table 4). The high prices obtained for tea and rubber during the last two years may have increased their earning capacities even more than the values given in the table. While these figures reflect a poor portion of vegetable production in macroeconomic analyses, it is not true for all vegetable growing areas.

Table 4. Income derived per sector in the agricultural sector in Sri Lanka.

Sector	Value
	(US¢)
Fishing	22
Cultivation of paddy and other field crop grains	15
Coconut cultivation	13
Other agricultural production	13
Livestock production	12
Forestry and logging	12
Rubber cultivation	11
Vegetable and fruit gardening	11
Tea cultivation	8

In Nuwara Eliya, high incomes are obtained by vegetable growers (2), which compare favorably with the income derived from plantation crops under good management. Studies are urgently needed to identify the specific reasons for poor performance in certain areas so measures can be taken to correct them. Unless income from vegetable cultivation can be made to compare favorably with that from other agricultural activities, it will be difficult to attract young farmers to this sector. Interest in improving the technology of production will also be more difficult to stimulate.

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DISCUSSION

Calkins: What we would like to do this morning is try to define, as Dr. Senanayake discussed in Table 2 of his paper, basic agroclimatic zones in the region so we can begin to think in terms of common problems. have drawn up a tentative list which we could use for discussion.

1. Lowland tropical,with generally heavy rainfall throughout the year.
2. Lowland semi-arid,as in northeast Thailand.
3. Lowland wet and dry seasons, as in some parts of Indonesia.
4. Lowland with 3 seasons: hot, dry, and wet, as in Taiwan.
5. Upland subtropical.
6. Upland temperate above 2000 meters above sea level, which is suitable for temperate fruits like apple.

Senanayake: In the wet highland region in Sri Lanka, the climate is cool. Temperate vegetables are grown year-round. The rainfall pattern has two peaks with intermittent rainfall in between which is suitable for vegetable growing. Traditionally, this area has grown temperate types of vegetables.

Moomaw: The Koppen and Thornthwaite systems of climatic classification as reproduced in the SEARCA proposal have gained wide acceptance. They can serve as a preliminary basis for discussion to insure standardization.

They are rather broad and general and may not fit specific national systems, but you could make special modifications to suit vegetable production.

Calkins: Another source of climatic information can be found in the last three pages of Mr. Pandey's paper. What we could do for each country is identify three major types of climatic zones and present this information on one page together with data on temperature and the rainfall pattern. Having all these data on one page will enable us to draw significant conclusions on climatic patterns in each country and the region as a whole. We hope that upon your return to your country, you could send us as accurate climatic data as possible.

Senanayake: What are the distinct climatic types of your respective countries that are suitable for vegetable production?

Hansani: In Indonesia, we have lowland-dry, midland-dry, highland-dry, lowland-wet, midland-wet, and highland-wet which can be used for vegetable production.

Anothai: The climatic condition in Thailand is more or less the same as in Sri Lanka. This would be easy to present graphically as on a map.

Due to high costs in transporting crops from the highland, vegetable cultivation has gradually shifted to lowland areas, especially around Bangkok.

Senanayake: Most if not all of us pointed out the constraint imposed by inadequate seed production. Are there comments regarding this?

Yang: If you intend to go into seed production, identifying major vegetable diseases of the crop concerned in the country becomes important. Data on wind direction and velocity can help indicate the potential degree of infestation of diseases transmitted by wind borne pathogens. You may also collect data on cloud formation, solar radiation, relative humidity, dew period, and soil types.

Senanayake: Land infestations cause a drain on foreign exchange. For purposes of local seed production, we need more refined technology. What usually happens is we use the same technique for seed production as in vegetable growing; thus, seed vigor is not always assured.

Opeña: In some vegetables, most varieties are open-pollinated and, therefore, they can be easily multiplied. But there are some types like common cabbage in which some of the popular cultivars are not open-pollinated such as the F_1 hybrids. This is not possible to reproduce unless the parental stocks are made available.

Our mandate at AVRDC is to develop open-pollinated varieties so that seed production can be facilitated, hence, seeds would be available at nominal prices.

Senanayake: We have also noted a tendency to disregard certain plant characters such as cold requirement for flowering of temperate vegetables. It would be worthwhile to identify vegetable species and cultivars that have low cold requirements in our respective countries and send materials to AVRDC for study and improvement. Another alternative is to have these

or varieties grown in areas favorable to flower initiation and seed development.

Opeña: On the other hand, we could explore further possibilities in the area of heat tolerance.

Tsou: We should consider the fact that we have limited time to effect all these recommendations. Right now, there are several seed production programs in each country. We should concentrate our effrots in identifying what these existing programs lack at present. How can we help in terms of technical assistance and facilities?

Somporn: AVRDC could increase the supply of breeder seeds of heat tolerant varieties to member countries. But we do our own selection to suit our conditions and farmers' preferences.

Senanayake: Not much research on seed production is conducted in Sri Lanka. What about in other countries? Do you feel we should do more research in this area?

Razzaque: In Bangladesh, not much research on seed production is conducted.

Banchong: In Thailand we conduct research on seed production, but we do not have any seed law to enforce the seed production industries in Thailand to produce good, viable, and true-to-type seeds yet.

Handani: We have mostly worked on foundation seeds but not for multiplication purposes in Indonesia. We can produce potato seed, especially for the small farmers, but so far we have not been successful with cabbage. We import most of our vegetable seed from Europe.

Bautista: In the Philippines, we produce adequate amounts of seed of local types even if these are not the best quality. We still import seed materials of temperate vegetables, principally from the United States, Japan, and Taiwan.

Calkins: It seems that we have cited sufficient evidence to develop seed centers in the mountainous regions of selected countries, especially for the *Brassica* types of vegetables. These centers could provide for the seed requirements of other countries participating in the network at a cost lower than the price from traditional supplies.

Senanayake: Regarding varietal testing, what has been done in respective countries by AVRDC.

Opeña: At present, adaptability tests are conducted in the different countries. AVRDC conducts tests in countries where AVRDC has outreach programs. We also have scientist-to-scientist programs or contacts in Malaysia, Thailand, the Philippines, Guam, Bangladesh, Sri Lanka, and Indonesia, who collaborate with us regarding performance testing of our breeding materials. We hope to extend our area of varietal performance tests later but this is not possible at present. Also, we send either established breeding lines or segregating populations to interested countries which perform their own tests and select those lines to be released to farmers.

Senanayake: High yielding varieties may turn out to be fertilizer res-

ponsive and would contribute to the high cost of production like the HYV varieties of rice. Is AVRDC developing varieties that do not require as much fertilizer?

Tsou: The breeders at AVRDC consider the needs of other countries as they try to develop a more effective system of developing varieties. This effort would be helped, if each country would inform us their specific needs.

Anothai: In sweet potato. we need a higher water content besides the protein content. The variety should suit the eating habits of the people. So, this is where we need to study consumer preference.

Calkins: We have not included consumer preference in the survey yet. We feel that at this stage , we should concentrate on pre- and post-harvest technology. Consumer preference can be investigated at a later stage.

Opeña: On the other hand, information on consumer preference could guide plant breeders in developing new varieties.

Somporn: Could we explore the feasibility of inviting the staff of AVRDC to work with scientists in our country? Khon Kaen University has developed three heat-tolerant tomato cultures but they are susceptible to leaf blight. Would it be possivle for Dr. Yang to help transfer genetic resistance to these cultivars?

Yang: If you have a trainee to bring the materials along with him for the research training project at AVRDC, I am certain that we can work this problem out between the breeders and the pathologists.

Somporn: Our problem is how to get together. We have breeding work in Khon Kaen, but the disease control aspect is done in Kasetsart and Chiang Mai.

Senanayake: Another possibility is to send planting materials of these cultivars to AVRDC for improvement, then AVRDC sends back the improved crosses for testing.

Yang: Yes, we completed a similar case with a Korean research intern through a disease resistant breeding program on Chinese cabbage two years ago. A cultivar is never a finished product. Other diseases may appear later in varieties that are resistant to current diseases. Also, we cannot study all diseases. Dependent upon the economical importance and breeding necessity, we have to observe priorities. At present, we are emphasizing the studies on late blight and bacterial wilt diseases because these are the most widespread and damaging diseases on tomatoes and white potatoes. Of course, we also work on other diseases but not as intensively as on these two.

Castro: This problem could be tied in with manpower training. Usually, our resident interns bring with them materials to work on during their training period. They receive guidance from our resident scientists who devote some time to help these trainees even if their problem is not within the priority program.

Senanayake: Let us shift our discussion to water management. Dry zones vary in different countries. In certain areas, there is sufficient

moisture to grow one crop even during dry periods. What problems do you encounter in your countries on this aspect?

Tsou: I think we should think in terms of basic principles of growing vetetables. Then we could adapt these principles to available resources. In the training programs, for instance, the principle is not to let tomato leaves touch the ground. Then, the workers are provided different methods such as mulching or trellis support.

Somporn: The farmers already know these things even more than the agricultural workers. What they need from us are good seeds.

Senanayake: Are there other points we should raise at this point?

Calkins: Let's not forget entomological problems. In the survey, we will need trained entomologists to identify insect pests.

Senanayake: We also need more information on sequential cropping and mixed cropping for maximum land use.

VEGETABLE PRODUCTION AND MARKETING IN THE HIMALAYAN KINGDOM OF NEPAL

Dhruba Raj Pandey+

To study the existing production and marketing situation in Nepal, one must have a basic understanding of the country's wide and varied geographical and climatic conditions. The different production functions depend a great deal on the temperature range within a given area, the amount of annual rainfall, and the accessibility of a market center.

GEOGRAPHICAL AND CLIMATIC CONDITIONS

The Tarai Region

The tarai is a flat region with elevations ranging up to 200 m. The climate is tropical with an average temperature of 30°C. The annual rainfall in the eastern tarai ranges from 2000 to 1000 mm/year in the western tarai.

In the tarai crops such as tomato, brinjal, okra, and most of the cucurbits are grown. Onion and cabbage are also grown in this area on a limited scale during the cold season. In areas close to the towns, small areas for commercial production are planted with vegetables, taking advantage of the local markets.

However, in areas that are far from the markets, production is very limited and occurs mainly during the monsoon season. Because of the seasonality of rainfall, fresh vegetables are not always available.

The Midland Hills

This region consists of mildly sloping hills and fertile valleys. The elevation ranges from 600 to 2000 m and, therefore; the climate is classified as subtropical or warm-temperate depending on the elevation. This spectrum of climatic conditions makes this area very suitable for the production of all types of vegetables.

In the midhills, the trend is also toward increased production around market areas because vegetable production is more profitable when the distance to the market is reduced.

The Himalayan Region

Due to extremely high elevation, ranging as high as 8848 m in the Himalayan region, there is very little cultivation of vegetables. During the warmer seasons there is some production of radish and turnip, which require very short growing seasons. But conditions do not warrant commercial production.

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The Inner Himalayan Region

This region consists of dry and cool valleys similar to the Tibetan plateau. The elevation ranges from 2400 to 5000 m. These valleys form a transition zone between the north Indian monsoon region and the arid high plateau of Tibet.

Because of the arid conditions and the extreme distance from market centers this area is being developed as a seed production center for cabbage, carrot, radish, turnip, peas, beans, and broad leafed mustard.

Production and Development Situation

Currently, the area under vegetable cultivation is approximately 82,000 ha covering about 3.5% of the total land area. The largest amount of vegetable production is found in Kathmandu Valley in the midhill region. A limited number of growers specialize in vegetable production, but in most cases where there is vegetable production, it is incorporated into a mixed cropping system with paddy or maize. Vegetables therefore, are abundant in Kathmandu Valley , particularly from November to June. Although production is very high during the rainy season, transportation is difficult unless a good market is available, as is the case in Kathmandu Valley.

In areas outside of the valley production is mostly on the kitchen garden level. However, as mentioned earlier, commercial production is beginning around the urban market center.

Seventeen horticulture farms have been established, 5 in the tarai, 10 in the midhills, and 2 in the inner Himalayan region for the development of the horticulture industry.

In 1972, a Vegetable Development Division was created within the Department of Agriculture. The central farm is located in Kathmandu Valley. It coordinates and participates in the following developmental programs.

1. Breeding of local varieties of onion, cauliflower, radish, brinjal, and sponge gourd.

2. Screening of local and imported varieties of cabbage, cauliflower, radish, turnip, carrot, peas, beans, tomato, brinjal, chili, and capsicum.

3. Introduction of different vegetables and testing the exotic types and varieties in the various geographical areas and climates.

4. Foundation seed production on the horticulture farms and commercial seed production on contract by the farmers.

The average size of a vegetable farm varies from 0.06 to 0.13 ha in the winter and 0.04 to 0.06 ha in the summer. There is a tremendous potential for expanding the vegetable and vegetable seed production if the limiting factors are effectively dealt with.

The Marketing Situation

Marketing of the produce after harvest is always a very important and equally difficult aspect of the production and distribution process. The hilly and mountainous terrain of the country make marketing even more difficult than in many other countries.

Immediately after harvesting and cleaning, the produce is taken to market, where the small growers sell their produce directly to consumers or to retailers.

The retailers or middlemen collect the vegetables from the production areas directly or they buy the produce in the market. The farmers located far from the market have to sell their produce to middlemen. There are some jobbers who collect the vegetables outside the valley production areas and then sell to the middlemen in the urban centers. Farmers or jobbers bring their produce to market on their backs, pushcarts, or trucks.

A few wholesalers transport off-season vegetables within the country and sell them to retailers. The sorting and grading of vegetables often take place in the production areas when the vegetables are sold directly to professional dealers. Sorting and grading at the retail level does occur, however, when the retailer buys the produce at the local assembly points.

Storage of the undisposed vegetables is done on the ground floor of the retailer's residence. Buying and selling of vegetables is at its peak in the morning. In the evening, prices are slightly inflated because of the dominating position of the middlemen.

In the tarai and midhills, weekly local markets are a main attraction for the people. Vegetable growers take their produce to the weekly markets. People enjoy buying vegetables at these markets and get a number of choices at them. Seedlings and seeds of the seasonal vegetables are also sold in these markets.

There is a tremendous potential for increasing the farmers' income by increasing vegetable producton. Table 1 shows data collected by the

Table 1. Average cost and returns of vegetables and cereals production in Kathmandu Valley.

Crop	Cost	Return	Profit
	(US$/ha)		
Winter vegetables	226.08	495.36	269.28
Wheat	108.00	160.00	52.00
Summer vegetables	342.80	868.80	526.00
Paddy	123.36	237.60	115.04
Maize	59.20	148.80	89.60

Food and Agricultural Marketing Service on the average cost and returns of vegetable production in Kathmandu. The profit potential for vegetable production greatly surpasses that of cereal crops, such as paddy, wheat, and maize.

Problems in Production, Marketing and Storage of Vegetables

Good Seed

Most of the farmers in the country maintain their own vegetable seed for the next season from a few plants which are often of poor quality. Seed of improved varieties is multiplied and sold to the farmers through horticulture farms every year, but this not enough to meet the increasing needs of farmers. There are no private seed growers in the country. Therefore, most of the growers depend either on the government farms, imported seed, or seed they have maintained themselves.

Disease and Insect Pests

There are some serious diseases attacking many of the important vegetables; for example, late blight, mosaic virus, and wilt on the tomato; leaf curl virus in chili; powdery mildew; rust and wilt in peas; mosaic in broad leaf mustard; and *alternaria* in cauliflower, mustard, radish, and onion. Damping-off is the most serious disease affecting seedlings in the nursery.

Insect pests have also become a big problem in both summer and winter vegetables. During the rainy season, the brinjal fruit and shoot borer is very serious and cucurbit fruit flies render cucurbits unmarketable. In the winter and spring, cabbage loopers on cole crops, and aphids on mustard and turnips reach serious proportions. The applicability and use of fungicides and insecticides are little known to farmers. This, along with the cost factor involved in buying these chemicals, makes it very difficult for many of the farmers to use them and adds to the risk of producing vegetables in Nepal.

Irrigation

About 100% of the area is irrigated in the tarai and inner Himalaya region. Very little irrigation is found in the midhill region, which is its most limiting factor for winter and summer vegetable cultivation. For this reason, vegetables are commonly cultivated in the rainy season.

In the tarai, tube wells or dug wells are the more common types of irrigation, but these are few in number.

Modern Technique Production

In Nepal, there are some traditional vegetable growers who use their own methods. Many people in the country do not know how to cultivate vegetables on a commercial basis. For successful production of vegetables, a sound technological base is certainly essential.

Daily Diet

Although vegetables are included in the Nepali diet, they are not a common part of the average Nepali diet. Presently, the average vegetable consumption per person per day is 91 g. This is clearly not enough to meet general nutr'tional standards. Those who know the importance of vegetables in the diet consume a good amount but a larger sector of the population consumes much less. Only selected vegetables like radish and chili are consumed in some areas, neglecting the other vegetables.

Marketing

In the city areas, farmers bring the produce to the retailer who is a permanent buyer, or the jobbers go to farmers themselves and collect the vegetables at a very low price. This way, much of the money paid by consumers goes to middlemen.

There is a glut in the sale of vegetables like onion, cauliflower, brinjal, etc. during the harvesting peak period. These cannot be stored and sold during the off-season because of the lack of processing and storage facilities. Another factor is that the farmers and jobbers do not have proper market places for the sale of their produce. Proper methods and channels of marketing vegetables are yet to be developed.

SUGGESTED METHODOLOGIES

Organization of Market

Due to the lack of well-organized market facilities, there is uncertainty as to whether the produce would be disposed of in time. Growers and consumers have felt that there should be some permanent market places for selling and buying fresh vegetables located in several places in the large cities.

With the help of the local government, market places are being established in suitable locations. A network of quick transport vehicles, storage, processing, and handling yards now has to be developed.

In periods of surplus supply, if good storage facilities are provided in the production areas, farmers will have confidence in their ability to dispose of their produce in time. A few cold storage facilities in important places are very essential to the stabilization of vegetable prices. Some of the vegetables that need storage at the time of peak production are cauliflower, onion, and potato.

There are some tomato producing areas that would greatly benefit from local processing units. During times of surplus supply, the surplus could be utilized in this way. This would provide another outlet to tomato farmers who generally cannot obtain good prices for their produce in times of surplus production.

Vegetable Production Areas

A few potential areas in suburbs and along the highways are being identified and studied for vegetable production. Attention is being given to the type of transportation needed to bring the produce to market as quickly as possible. Most of the growers are unable to bring their pro-

duce to the city markets, therefore, they must depend on the local market or on roadside buyers. This is the main constraint on the expansion of production.

Cooperative organizations are needed to solve this problem The organizations should consist of farmers, representatives, field technicians, and credit concerns. They would be responsible for arranging the input and credit facilities, and collection and dispersal of the vegetables at suitable marketing centers.

Vegetable Seed Production Areas

There is no sound vegetable seed industry due to a lack of technicians. The increasing demand for vegetable seed makes it necessary to develop a seed production program. To control seed quality, foundation seed is being produced on the government horticulture farms. In 1976, small-scale seed processing units were established in three of the seed production farms. These farms are located in three regions of distinct agroclimatic conditions. They are under the supervision of the Vegetable Development Division.

The Marpha farm in the Inner Himalaya region has become the most productive center. Farmers in that area are assisted by farm technicians in producing a large quantity of commercial seed. Seeds of some of the vegetables are distributed in packets to backyard gardeners.

To strengthen the vegetable seed industry, surveys have been conducted in different parts of the country. Priority has been given to multiplying seed of the most successful vegetables. Farmers who are involved in seed production are getting not only field assistance, but also credit and a guarantee for the sale of their seed.

Ecological Studies and Varietal Testing

Crops and varieties are being screened for adaptibility on the horticulture farm in different areas. The testing of fungicides and insecticides, along with the varieties has also been started in different ecological regions.

Vegetable promotion is being done through UNICEF nutritional programs and local women trained in home economics. These women are successfully introducing the importance of vegetables for human nutrition. Students who go to remote places under the National Development Service also perform extension work in vegetable promotion. A backyard garden program is also being introduced in the schools and colleges. All of these activities are being coducted to strengthen and expand the backyard garden program.

CONCLUSION

Vegetable production can upgrade the economic condition of the poor farmers and improve the diets of the population as well. Due to the success of the vegetable development program in Nepal, there is a tremendous demand for vegetable seed. This situation requires a well organized national program. International assistance is imperative to build a strong technological base. This international assistance, in the long run, can help expand the tremendous scope and potential in the field of vegetable seed production offered by the diversified agroclimatic situation in the country.

DISCUSSION

Moomaw: Are services or systems being developed to help the farmer perform some of the services now provided by the middlemen, such as rural packing and assembly sheds?

Reducing the share of middlemen requires a plan or model for providing these services at government subsidized costs. To help the farmers, marketing costs should be reduced.

Senanayake: In Sri Lanka, the Marketing Department and the Cooperative Marketing Organizations like MARKFED have collecting centers which are nothing more than simple sheds. Here a certain amount of grading, cleaning, and dressing may be done. But cleaning and grading at the collecting end would not help because of the poor handling, transporting, and unloading that follows. Cleaning at the farm, therefore, will be self-defeating because the produce will have to be cleaned once again at the wholesale market and thus only would increase costs.

In order to adopt a system like Taiwan's, refined handling, containerization, and movement of the produce should be developed. It could, however, be adopted if the produce is directly exported or processed where further handling is unnecessary. But for local consumption, the whole marketing process needs to be changed.

Isada: In the Philippines, we have developed a cooperative system of marketing called Area Marketing Cooperative. A number of farmers associations are involved. The National Grains Authority, a government agency, takes charge of marketing cereals. However, there is no government organization to take care of the marketing of vegetables. For specific commodities, though, like tomato, there are companies such as the Philippine Packing Company that have efficient collection systems. The small farmers, through a government program (Gulayan sa Kalusugan), are encouraged to imitate the marketing scheme of the Philippine Packing Corporation.

Pritana: In Thailand, there is no government agency involved in vegetable marketing. The farmer does the packing, grading, transporting, storing, and processing; whereas the middlemen do the distributing. The middlemen control market prices.

Anothai: We have a central vegetable market but because of the density of the population, we have transportation difficulties. Our middlemen specialize in specific commodities and they control the business. They have a credit system wherein farmers are told to bring a certain amount of their products and the payment is sent later.

Hansani: In Indonesia, the commercial vegetable marketing channel is as follows:

Producer (farmer)	20-40% from retailers' price
Collector	
Financier - collector	
Market wholésaler (central market)	
Smaller market retailer	
Vendors	profit margin 40-50% of retail price
Consumer	

For farmers who produce small quantities, it is not worthwhile to sell produce to the market because the middlemen get most of the profit.

Wang: In Hawaii, we have been trying to organize farmers into a sizeable group that would be effective but we have not been successful so far.

I think marketing is not the problem but production management. We should look at the two ends of marketing. Is the price too high or too low from the consumer's or farmer's point of view? Both farmers and consumers should be protected.

The problem of marketing is the elimination of uncertainty.

Tsou: The problem of marketing is associated with the development of agriculture: In the marketing system, is the price at the right level to stimulate the farmers and consumers?

In Taiwan certain programs to improve the middlemen's position are being developed.

Calkins: In fact, AVRDC is planning to conduct a survey in Taiwan which could be a model for other countries. The channels to be studied are:

1. Traditional, where there are numerous marketing intermediaries.

2. Producers' cooperatives or farmers' organizations through which credit information, seeds and some machinery can be obtained; there is also provision for joint ownership and joint marketing.

3. Specialized vegetable areas which have a direct link to major, urban wholesale markets.

4. Processing outlets which constitute the shortest channel from the producer to the processing plant on a contract basis and to final and export markets.

We hope to develop a fifth channel which would be a hybrid of the best characteristics of the other four channels.

Many governments in Asia are trying to evaluate their programs. A survey, as outlined above, is perhaps the best way to rationalize market analysis. Through a network, we can see what improvements might be made in each country.

Pandey: We are proposing farmers' cooperatives and collection centers in strategic areas so as to be able to bring produce to the markets and sell directly to the retailer or consumer.

Rikken: Several attempts have been made but failed to rationalize the marketing system through government agencies or cooperatives. The main reason, I think, is that rationalization is constrained by cultural factors which reflect the prevailing economic conditions.

Marketing provides employment to many people and provides them a living, and as such, serves as a mechanism of income distribution. Unless the unemployment problem is reduced considerably, it will be difficult if not impossible to rationalize the marketing system in favor of the farmer-producer.

Castro: Planning should be done right at the start at the pre-harvest period, not only in organizing farmers but the whole farm-to-market system because it is not only a marketing problem.

Isada: We are trying a scheme where production will meet market demands. The government is identifying areas where organized groups of farmers will be able to match production with apparent demand based on the quantity of produce that the traders can sell or market in a given period.

Last year, we were able to stabilize the prices of tomatoes on the farm which gave at least 30% mark-up over the total cost of production for growers in Northern Mindanao.

Senanayake: Since vegetable production in Sri Lanka is in more specialized areas, it would be advantageous to organize the producers into Producer Cooperatives or Associations. Cooperation could also bring about economies of scale in production technology and marketing. In such a system, prediction of output as questioned by Dr. Wang yesterday and distribution of labor use as commented on by Dr. Rikken today could both be satisfied.

In recent years, special experimental projects were initiated in certain settlements called colonization schemes in which organizations of management and better extension have improved technology and productivity. In these settlements, the main crops were cereals, dry legumes, and condiments. This example could be replicated in vegetable growing areas.

Personally, I would feel that in Sri Lanka the government would favor the development of producers associations or cooperatives to improve the marketing problems of the vegetable sector.

Tsou: In your illustration, the consumer is far away from the producer but in most areas in Asia, the producers and the consumers are the same people. We have identified more market areas in the urban centers. Are we assuming people in the rural area produce for their own needs?

Castro: Market can only be regulated through production or within the farm it should be organized production.

Calkins: Numbers 1 through 7 on our post-harvest list are potential operations which may or may not be done. The producer may in some cases be the consumer.

To rationalize our analysis, we might adopt the agribusiness approach. This includes four areas.

1. The provision of inputs or "pre-planting" technology.

2. Production.

3. Processing and storage or "post-harvest" handling.

4. Marketing and distribution to final consumer. Indeed, the availability of markets is perhaps the most important incentive to increase production.

Wang: Where would price stabilization enter in the chart?

Calkins: There are a number of ways through which we could stabilize prices. Remember the natural, technical, and institutional approaches of solving problems which we discussed earlier? What we are now considering are institutional procedures. These may be in the form of price subsides or organized groups which govern operations.

Yang: Would the market information also include forecasting systems?

Calkins: Definitely. For integrated decision making, we shall need a simultaneous system.

Choi: We have two channels for marketing.

1. From production area to wholesaler to retailer.

2. Farmers association (semi-government) - middlemen - markets.

Anothai: Vegetable growers who sell their produce to processing plants should be informed of the price beforehand but due to technique of processing, price of fresh vegetables should be lower. Growers should be informed of prices early enough so they can plan their operations such as variety of plant and fertilizers to use.

Growers should enter into contracts with processing factories, or else the middlemen go to the growers and offer a better price for their produce. Then the processing plants have a shortage of vegetables.

Tsou: Vegetable processing plants should be located within the production area as in the case of sugar plants. We could learn a lot from the sugar processing industry about the execution of contracts, transportation, handling, etc.

Isada: The Philippines has the same experience as Thailand with regard to contract growers. Processors of cucumber, which is primarily grown for processing, do not have much competition from the middlemen. On the other hand, farmers who raise vegetables or crops that have a high demand generally do not want to enter into contract growing. If they ever do, some of them tend to sell a portion of their produce to anybody who can offer a higher price than that agreed upon in the contract.

Calkins: As Dr. Anothai mentioned yesterday, there must be loyalty for any system to work. In Taiwan, contracts are processed through a farm organization. Any farmer who does not honor the terms of his contract loses face.

Senanayake: With reference to Dr. Anothai's comment, I wonder whether it would be possible to link processing with seed extraction and sale. It would not be possible with all crops but the possibility exists with crops like tomato, peppers, and cabbages. If the processor could return the seeds to farmers' organizations and if the seed were then marketed systematically, the growers would receive a second income. The influence of the middlemen trying to purchase for fresh market the vegetables that were originally meant for processing could thus be reduced.

Tsou: Price guarantee is not enough; farmers' income should be guaranteed, too, in terms of yield and price. Processors should send out technicians to help farmers raise their crop yields.

Calkins: In the post-harvest stage, there are labor intensive technologies which could insure high quality products for export. The processing industry is a potential source of labor absorption, especially for quality control operations.

Rikken: If processing plants are distributed all over the country, the labor force would be more extensive.

THE STATUS OF VEGETABLE PRODUCTION AND MARKETING IN BANGLADESH

Abdur Razzaque+

Bangladesh is a country of 142 thousand km^2 and has a population of about 80 million people. It is between 20.5°N and 26.5°N latitude and has an average elevation of 46 m above sea level. Bangladesh is a riverine country with 87% of its area comprised of plains and the rest consisting of low hills. The hills are in the northeast and eastern regions of the country. In general, the soil of Bangladesh is very fertile, containing, on the average, 1% N, 1% P, 1% K, 1% Ca, and 4% organic matter. The annual monsoon replenishes soil fertility through siltation.

The annual precipitation varies from 1112 to 5096 mm or an average of 2076 mm. Rainfall is concentrated during the months of May to October. Almost no rain falls during the period November to April and crop production is impossible without irrigation.

Bangladesh is in the humid tropical region. We have a well-defined winter season when temperature varies from -3 to 12°C, whereas the temperature normally varies from 10 to 21°C during the summer season. The day-length from November to March ranges from 10 to 12 hr/day, whereas from June to September it varies from 14 to 12 hrs.

The soil and climate of Bangladesh are suitable for growing a number of crops including vegetables. Out of the total cultivable area of 9 million ha only 0.2 million ha are utilized to grow 0.8 million t of vegetables annually.

During winter months, the growing of vegetables is dependent on the availability of irrigation water, whereas, during summer, particularly in the months of July to October, the country experiences heavy and continued raingall. As a result, drainage becomes an acute problem. Bangladesh grows a good number of vegetables in both seasons of the year. The area, total production, and yield of vegetable crop are shown in Table 1.

AREA AND PRODUCTION

Vegetables play an important role in daily food intake. They are rich in protein, minerals, salt, and vitamins. In the years 1962 to 1964 a nutritional survey was undertaken which revealed that 85% of the people of Bangladesh were suffering from protein deficiency, and 46% from calorie, 40% from vitamin A. and 30% from iron deficiency. The present situation must have resulted from the rapid growth of the population.

Obviously, vegetables can make a great contribution in alleviating nutritional deficiency in Bangladesh. In a balanced diet, the intake of vegetables per day would average about 142 g. The annual requirement of

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Table 1. Area, production, and yields of winter and summer vegetables in Bangladesh, 1974-1975.

Vegetables	Area	Production	Yield
	(ha)	(1000 t)	(t/ha)
Winter Vegetables			
Cauliflower	4,717	30	6
Common cabbage	4,929	35	7
Tomato	6,862	52	8
Beans	4,065	21	5
Brinjal	16,740	119	7
Winter gourd	4,437	33	7
Pumpkin	5,049	38	8
Spinach	1,723	7	4
Radish	8,950	64	7
Others (Knolkhol, gourd, carrot, turnip, Amaranthus, lettuce, etc.)	7,577	34	4
White potato	79,587	747	9
Sweet potato	63,730	681	11
Total	208,366	1,860	
Summer Vegetables			
Pumpkin	4,217	30	7
Brinjal	9,512	66	7
Patal	2,395	17	7
Lady's finger	1,747	7	4
Ribbed gourd	2,615	15	6
Bitter gourd	3,022	17	6
Arum	4,774	34	8
Puisak	1,255	6	5
Snake gourd	2,395	14	6
Cucumber	2,389	13	7
Others (Kakral), Amaranthus, white gourd	4,295	24	5
Total	38,945	243	
Grand Total	247,312	2013	

vegetables for the 80 million people of Bangladesh would be 4 million t/yr whereas the production of vegetables is only about 2 million t. To fill this gap, Bangladesh should double its vegetable production by increasing yields for all vegetables. The scarcity of vegetables, particularly during the summer, is a severe problem.

Higher production of vegetables during the winter in Bangladesh may be attributed to the following factors.

a. More cultivable land is abailable for winter vegetables.

b. Seasonal adaptability. A good number of vegetable crops such as white potato, brinjal, sweet potato, radish, and tomato are only grown during the winter.

c. Floods, cyclones, and rainfall do not occur during the winter months.

The crucifers, other than radish, were introduced long ago. But because of higher consumption and ensured market, these crops are primarily grown within and near the cities. Tomato, another introduction, is now grown extensively in Bangladesh. The summer vegetables, being local or indigenous, are grown all over the country.

Seasonal Availability

All the green, leafy vegetables that are produced in either season are consumed as fresh vegetables. Some starchy vegetables like sweet potato, aroid, pumpkins, and white gourd are consumed not only in fresh condition; a portion of the produced is often stored by the growers for periods of a few days up to one or two months at normal room temperatures.

The peak harvest period of winter vegetables is from the middle of January to the middle of April; summer vegetables, from June to August. In case the vegetables are damaged in the field by heavy rains or flood water, they are harvested immediately. Thus, there is a short slack season from middle of April to the middle of May in which only white potato and some summer vegetables such as amarnaths, bitter gourds, and pumpkins are harvested.

On the other hand, a long slack season of about 4.5 months begins in September during which time fresh vegetables become very scarce. This is partially relieved by brinjal, cowpea, and potato from cold storage during September and October. Some early vegetables like potato, radish, beans, cauliflower, and bottle gourd become available in the months of November and December. The latter are produced early in the northwestern areas of the country where the land is at a higher elevation and receives less rainfall.

Among the vegetable crops grown in Bangladesh, only potato is stored either under ordinary room temperature or in cold storage until the next crop is harvested. Ordinary storage is done on a small scale by the growers. They have to pick the rotten tubers occasionally, leaving the good ones, so that by the time the planting of seed for the next crop begins the stock is nearly exhausted.

Seventy-one cold storage units were in operation is 1976, having the capacity to store about 87,000 t. These are mostly used for the storage of

seed and table potatoes, though some storage units keep perishable items other than potatoes. Sweet potato is the only other vegetable which is stored under ordinary room temperature, but it is stored for two months at the most. The sweet potato producers do not have adequate incentives to use cold storage because of the relatively low price of sweet potato compared with white potato.

Seeds and Varieties of Vegetables

Seed of certain winter vegetables like cabbage, knolkhol, beet, and turnip cannot be produced under the climatic condition of Bangladesh. Consequently, the country has to depend entirely on imported seeds to be able to grow these vegetables. Seeds of cauliflower varieties with the exception of the snowball, can be produced in Bangladesh. The seeds of other winter vegetables are usually produced and maintained by the farmers themselves.

Tomato varieties that are being grown in the country include Oxheart, Sanmarzano, and many others which were introduced from abroad. The introduced tomato varieties are susceptible to virus infection. Brinjal is the only crop that can be grown both winter and summer. There are very good local varieties of brinjal but these are yet to be purefied. Beans, particularly *Dolichos lablab* sp., require a long growing season. The seeds are produced and maintained by the farmers themselves. The summer vegetables are mostly indigenous and have been grown for a long time in Bangladesh.

Red and white skinned varieties of sweet potato with white flesh inside are normally grown by the farmers from cuttings. Recently, some exotic varieties of sweet potato were introduced by the research organizations for trial and adaptation in Bangladesh.

White potato is one of the important vegetable crops,comprising about 30% of the annual vegetable production. The varieties that are being grown can be classified into two groups: (1)Indigenous varieties introduced long ago that have greatly degenerated and (2) exotic high yielding varieties that need to be introduced every year to keep the production at a satisfactory level. Most of the latter come from Holland.

Marketing of Vegetables

Vegetables are grown by farmers primarily as a crop subsidiary to major crops like rice, jute, and sugarcane. These are mainly grown in small-scale homestead areas. A great part of the produce is consumed by the farmers and most of the rest is sold in local markets without packing.

In the past, the commercial production of vegetables was limited. Recently, however, a trend has begun among some farmers around cities or towns to engage in the exclusive cultivation of vegetables as a commercial enterprise. However, these enterprises are not of the same stature as the truck or market gardens known in developed countries.

As a rule, the vegetables are not transported long distances. Some vegetables including cauliflower, cabbage, tomato, patal (*Trichosanthes dioeca*), brinjal, and beans are transported from one district to the other. For example, the production of patal during summer is mostly concentrated in the districts of Rajshahi, Rangpur, Borgra, Pabna, Kushtia, and Khulna, The bulk of the produce is consumed in Dacca and Chittagong

where the production of patal is negligible. Patal is packed in burlap bags or bamboo baskets and is transported by rail or bus.

Grading of vegetables is not a normal practice at the growers' end. Only the retailers do some grading while selling the commodity but only with white potato.

As with rice, jute, and other field crops, the product costs of vegetables are not considered by the farmers when selling. But unlike the sale of field crops, vegetable farmers cannot keep their produce to improve their bargaining position. Vegetables are too perishable. Thus, more often than not, vegetable prices are controlled by the middlemen and retailers.

Organizations to Boost Production

A number of organizations, including the Bangladesh Agricultural Research Institute (BARI), Bangladesh Agricultural Development Corporation (BADC), Bangladesh Agricultural Research Council (BARC), Bangladesh Academy for Rural Development (BARD), Horticultural Development Board, and the Directorate of Agriculture (Extension and Management), are involved in vegetable production.

Research and Extension

The Division of Horticulture and Vegetable of BARI and the Department of Horticulture of Bangladesh Agriculture University, are the primary organizations which conduct research on vegetables. Very recently, BARO has undertaken a number of research projects on vegetable crops. The research work of these organizations is mostly concentrated on varietal trial and adaptability of vegetable crops. Sophisticated or advanced research work on vegetable crops cannot yet be conducted in Bangladesh because of limited facilities.

The Directorate of Agriculture (Extension and Management), Horticultural Development Board, and BARD, conduct extension work on vegetable production.

Supply and Services

BADC is the only organization or agency which supplies seeds, fertilizers, and other inputs to farmers. Part of the seed is produced by the BADE in their seed farms and the rest is imported from outside from time to time. Seed of cauliflower, turnip, radish, cabbage, tomato, beet, and *Knolkhol* is usually imported from the United States and Japan every year. Besides this, Horticultural Development Board, BARD, and the philanthropic organizations also produce and import seeds for distribution among farmers.

VEGETABLE GROWING IN THAILAND

Banchong Sikkhamondhol[+]

Thailand is an agricultural country with a total area of approximately 50 million ha. More than 15 million ha is devoted to agricultural production of which rice is predominant. 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 by differences in annual temperature and rainfall (Table 1). The following three seasons are pertinent to all these regions.

Table 1. Average annual temperature and rainfall in four regions of Thailand (4).

Region	Annual temperature	Annual rainfall
	(°C)	(mm)
Northern	26	1000
Northeastern	27	1000
Central	28	1500
Southern	18	1000

Hot season - Late February to May

Rainy season - Late May to October

Cool season - Late October to February

The planted area and production of selected vegetables in Thailand as recorded by the Division of Agricultural Economics, Ministry of Agriculture and Cooperatives, from 1972 to 1974 are shown in Table 2.

Vegetables are important crops to the economy and a vital source of food to the Thai people. The average production costs of four major vegetables, as recorded by the Division of Agricultural Economics for the period 1963 to 1974, was about US$124 - 264 million (3).

Vegetable growing in Thailand has not progressed much. Over-population has made the diet of people in Asian countries preponderant in starch and poor in protein. Thailand is not an exception. The need for more vegetables in Thailand has become increasingly urgent due to the rapid

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Table 2. Planted area and production of selected vegetables in Thailand 1972-1974 (1).

	Plant area			Production		
	1972	1973	1974	1972	1973	1974
	(1000 ha)			(1000 t)		
Chili	47	35	31	85	76	60
Bird pepper	43	44	42	75	68	60
Ginger	7	5	4	54	32	25
Garlic	24	31	13	64	169	149
Chinese radish	14	9	9	125	85	89
Tomato	7	8	6	27	31	33
Sugar pea	3	3	6	5	5	5
Cabbage	9	10	11	69	65	99
Shallot	33	34	27	158	243	175

population growth and the development of a food industry which, at present, has a great demand for fresh vegetables of high quality. The projections for vegetable and fruit consumption in Bangkok have increased more and more. The consumption of the Bangkok population for fresh vegetables per capita per year was 31 kg in 1963, 37 kg in 1970 and 41 kg in 1975. Consumption is expected to be 45 kg in 1980. In 1975, the population of Thailand was 40 million, with the projected consumption of fresh vegetables amounting to 1944 million kg (2).

Commercial Vegetable Growing in Thailand

Vegetables grown for the market in Thailand belong to several groups (5). These are:

1. Perennial Crops

   Asparagus (*Asparagus officinalis*)

2. Potherbs or Greens

   Spinach (*Spinacia olercea*) Chinese type

   Basil (*Ocimum basilicum; O. sanctum; O. canum*)

   Cariander (*Coriandrum sativum*)

   Summer chrysanthemum (*Chrysanthemum coronarium*)

3. Salad Crops

Celery (*Apium graveolens*) Chinese and European type

Lettuce (*Lactuca sativa*)

Sweet corn (*Zea mays*)

Parsley (*Petroselinum hortense*)

4. Cole Crops

Cabbage (*Brassica oleracea* var. *capitata*)

Cauliflower (*B. oleracea* var. *botrytis*)

Broccoli (*B. oleracea* var. *italica*)

Brussel sprout (*B. oleracea* var. *gemmifera*)

Kohlrabi (*B. caulorapa*)

Chinese cabbage (*B. pekinensis, B. chinensis*)

Leaf mustard (*B. juncea*)

Headed mustard (*B. juncea* var. *rugosa*)

Kale (*B. albograba*) Chinese type

5. Root Crops

Radish (*Raphanus sativus* var. *longipinnatus*) Chinese and Japanese type

Carrot (*Daucus carota*)

Ginger (*Zingibera officinale*)

Colocasia (*Colocasia antiquorum esculentum*)

White potato (*Solanum tuberosum*)

Sweet potato (*Ipomoea batatas*)

6. Bulb Crops

Onion (*Allium cepa*)

Shallot (*A. ascalonicum*)

Garlic (*A. sativum*)

Chive (*A. tuberosum*), Chinese chive

7. Peas and Beans

Sugar pea and edible-podded pea (*Pisum sativum*)

Yardlong bean (*Vigna sesiquipedalis*)

Snapbean (*Phaseolus vulgaris*)

Cowpea (*Vigna sinensis*)

Wingbean (*Psophocarpus tetragonolobus*)

8. Solanaceous Fruit

Tomato (*Lycopersicon esculentum*)

Eggplant (*Solanum melongena*)

Chili pepper (*Capsicum frutescense; C. annuum*) and many native varieties.

9. The Cucurbits

Cucumber (*Cucumis sativus*)

Muskmelon (*C. melo*)

Watermelon (*Citrullus vulgaris*)

Pumpkin (*Cucurbita pepo*)

Squash (*Cucurbita mixima*)

Luffa (*Luffa cylindrica; L. acutangula*)

Bitter gourd (*Momordica charantia*)

Coccinia (*Coccinia indica*)

10. Miscellaneous Crops

Okra (*Abelmoschus esculentus*)

Roselle (*Hibiscus sabdariffa*)

Water convovulus (*Ipomoea reptans*)

Nymphea (*Nymphea lotus*)

Cultural Practices

Commerical vegetable production could be divided into two types. In one system, vegetables are grown in the lowlands. The soil types are clay and clay loam. The farmers grow vegetables on raised beds surrounded by a ditch. A high farm dike is constructed to control the water level and prevent flooding. Figures 1 and 2 illustrate this type of farming which can be seen around Bangkok and other provinces in Central Thailand.

The other system of commercial vegetable growing is observed in the hilly areas, the highlands and along river banks. Loam and sandy loam soils dominate in these areas. The beds are raised but lower than those

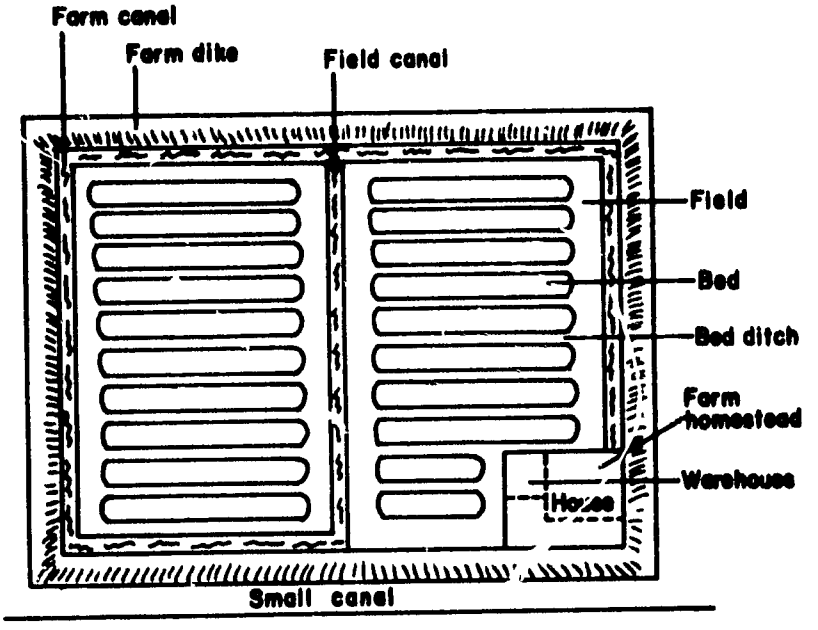

Figure 1. An illustration of vegetable farm layout used by farmers in the central region of Thailand.

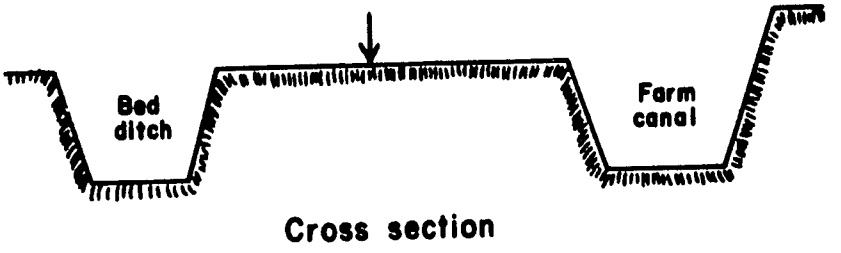

Figure 2. An illustration of the farm bed, bed ditch and dike.

in the Central Region. No dikes are constructed.

In some growing areas in the north and northeast regions, the elevation could be as high as 300 to 600 m above sea level where off-season production is profitable, largely due to the water supply that comes from the rivers and streams. An exceptional type of vegetable growing is practiced for particular species of vegetables such as water chestnut and Manchurian rice. This system makes use of cultural practices similar to those of rice farming in the lowland.

Due to the exceptionally high price of vegetables during the off season, the adatation of techniques and varieties to environmental conditions in this period is becoming important. At present, off-season production is rarely found in this country.

Commercial vegetable growing in Thailand is an intensive cultural practice. The farm size varies from less than 0.8 ha up to 1.65 ha in the central plains area. But the farm size in many regions is up to 8 ha or even more, especially in truck farming enterprises in the hilly area that have contracts with the food factories or vegetable suppliers of hotels and supermarkets. Some of these farmers own up to 48 ha and an exceptional few own more than 160 ha.

The multiple cropping system has been practiced commercially by growers in the north. The patterns of planting are rice-soybean, rice-tobacco, rice-leafy vegetable, rice-garlic or onion, rice-peanut, and rice-potato.

A project on multiple cropping using vegetables only is being conducted by Chiang Mai University with the support of the Ford Foundation. The results have been applied and practiced by farmers at several vegetable growing areas. Farmers could manage to grow and harvest 3 to 5 crops a year.

Vegetable Consumption

The biggest vegetable production area which supplies the whole country's consumption is located in central and western Thailand. Many kinds of vegetables are grown in this area and most of them are consumed as fresh vegetables. The production area is not far from the wholesale market in Bangkok. In Bang Wag it is only 20 km from the wholesale market. Chinese cabbage, Chinese Kale, leafy mustard, cauliflower, cucurbits, beans, and tomato are widely grown throughout the year. The total production area is about 1920 ha. The other growing areas is about 1920 ha. The other growing areas are located in Taling Chun, Pratum, Thani, Rangsit, Nontaburi, Minburi, Nongkham, Bangkok Noi, Nakorn Pratom, Rajburi, and Pechburi which are about 20 to 200 km from Bangkok.

Farmers in these vegetable growing areas send their products through wholesale market channels, which distribute vegetables to the other parts of the country as well as to the retail market within and around Bangkok. The vegetables are transported by boat and truck. Business at the wholesale dealer market starts early in the morning (0300) and continues until 2100 in the evening. The quantity and quality of fresh vegetables flowing through the market channels is an important consideration for adequate nutrition. The diagram of vegetable consumption is presented as Figure 3.

Diseases and Pests

The loss of vegetables caused by diseases and insect pests is estimated at 20 to 30% of the production each year, valued up to US$50 million or more yearly.

The important diseases attacking cabbage are soft rot, black rot, root rot or foot rot of seedling, and downy mildew. Being a tropical

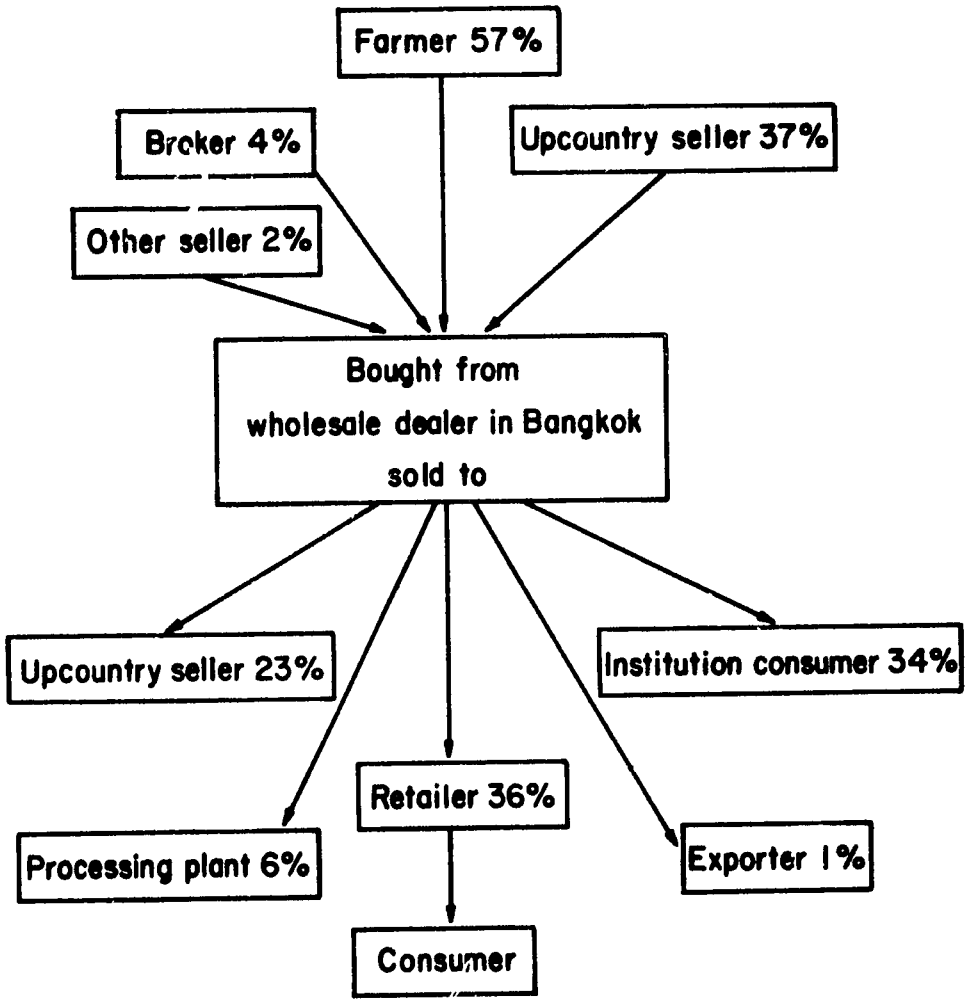

Figure 3. Diagram of vegetable consumption in Thailand.

country, Thailand has a climate that is very suitable for many diseases and insects.

The major pests attacking vegetable crops in Thailand are listed in the Appendix.

SEED PRODUCTION PROGRAM

Most of the vegetable seeds are imported from Taiwan, Japan, Australia, Denmark, the Netherlands, England, the United States, New Zealand, and France. There is no seed production in Thailand, except for a few growers who produce their own seeds in limited amounts. A majority of farmers depend entirely on imported seeds. Many seed dealers import a great amount of seed which they repack in Thailand; for instance, seeds of Chinese kale, Chinese radish, cabbage, Chinese cabbage, and other vegetables.

Local varieties of chili, eggplant, cucumber, asparagus, beans, and water convolvulous are grown to seed without varietal improvement and selection. Therefore, seed quality is quite low.

In July 1974, the following seeds were imported in great quantity.

Chinese kale	37.7 t
Chinese radish	14.6 t
Cabbage	12.2 t
Celery	5.8 t
Cauliflower	3.6 t
Watermelon	2.7 t

The total seed importation for all kinds of vegetable seed in 1973 weighed about 285 t and in 1974, for a period of only 8 months, 263 t of seed were imported (7). These figures were obtained only from the Department of Customs, Bangkok Harbor. The seeds could be brought into this country by other means and channels; therefore, the real amount of imported seeds could be much higher.

For the present, the research concerning vegetable production in Thailand will be concentrated along the line of breeding and selection in order to find out the suitable varieties to supply the fresh vegetable market and the raw material for food processing. To reduce the quantity of imported seeds, a seed production industry or even a group of small-scale seed growers should be established. Legislative acts to promote a seed industry were approved by the Parliament in 1975. At the moment, the details of rules and regulations are being studied and will be declared by the Ministry of Agriculture and Cooperatives as a tool for seed quality control in the near future.

The Department of Agriculture is responsible for the seed production program. The following improved varieties have been released as a stock seed to the Department of Agriculture Extension for multiplication (8).

1. Chinese kale (stem type) - PL 20
2. Chinese radish (early) - OW 1
3. Asparagus bean - (many lines)

4. Sugar pea (small pod) - MJ 12, MJ 55

(big pod) - Fang No. 7

Since vegetable research is carried out by different institutions, the National Vegetable Research Committee of Thailand has been established (in 1974) to pool manpower and equipment resources and improve the efficiency and application of research to field problems.

CONCLUSIONS

The year-round production of many vegetables is essential to a nation. The possibility of increasing the vegetable production area is quite reasonable. Big processing plants for vegetables and fruits are already settled in the northern part of the country. The Thai Government is planning to initiate land reform for agricultural development. At this moment a committee has been vested with authority to set up a master plan for land reform. His Majesty the King has donated the land for this purpose. When the land is developed with good irrigation and a transportation system, it is hoped that the farmer will turn to vegetable growing because the net income per unit area is higher and the farm size is suitable for intensive work. It is believed that vegetable production can be significantly increased with the use of new cultivars and improved technology.

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Appendix -- A list of major pests infesting vegetables in Thailand (3).

Host plant	Scientific name of pest	Common name of pest	Locality[a]
Cucurbits (cucumber, watermelon, pumpkin, etc.)	*Taeniothrip* sp.	thrip	N, CP, NE, SE
	Margaronia indica Saund.	leaf rolling caterpillar	CP, NE,
	Rhaphiopalpa similis Ol.	leaf eating beetle	N, CP, NE, SE
	Ceratia frontalis Baly.	leaf eating beetle	N, CP, NE, SE
	Dacus cucurbitae Coq.	fruit boring maggot	NE, CP
Beans & peas (bean, sugar pea)	*Lampides boeticus* Linn.	leaf eating caterpillar	CP, NE, N
	Maruca testularia Geyer.	Pod eating caterpillar	CP, NE, N
Bush bean	*Melanagromyza* spp.	stem & leaf mining maggot	CP, N, NE
	Aphio laburni	leaf sucking bug	CP, N, NE
Tomato	*Helicoverpa*	fruit and leaf eating caterpillar	CP, N
Balsam pear	*Ceratia frontalis* Baly.	leaf eating beetle	CP
	Dacus cucurbitae Coq.	fruit boring maggot	CP, N
	Margaronia indica Saund.	leaf eating caterpillar	CP
Eggplant	*Epicauta 28-punctata* Dist.	leaf eating beetle	CP, N, NE
	Urentius echinus Westw.	leaf sucking lace bug	CP, NE
	Aphis gossypili Glov.	leaf eating caterpillar	CP, N, NE
	Xanthodes transversa Guen.	leaf eating caterpillar	CP, NE
Yardlong bean	*Aphis craccivora* Koch.	leaf sucking plant louse	CP, N, NE
	Bruchus chinensis, L.	seed boring grub	CP, N, NE, SE
	Melanagromyza phaseoli	stem & leaf mining maggot	CP, N, NE, SE
Potato	*Cylas farmicarius* F.	stem and tuber boring beetle	CP, NE, SE
	Bedellia sumulentella Z.	leaf eating caterpillar	CP, NE, SE
Onion	*Thrips tabaci* Lind	onion thrips	N, NE
	Spodoptera exigua Hubn	leaf eating caterpillar	CP
	Cadra cautella Walk	bulb eating caterpillar	CP
Pepper	*Scirtothrips dorsalis*	pepper thrips	CP, N, NE
	Polyphagotarsonemus latus Bank	mite	CP, N
Sweet corn	*Ostrinia nubilalis* Hubn		CP
	Helicoverpa spp.	leaf eating caterpillar	CP,N,NE
Crucifers (cabbage, kole, cauliflower, etc.)	*Plutella xylostella* L.	diamondback moth	N, CP, NE, SE, S
	Trichoplusia ni Hubn.	leaf eating caterpillar	N, CP, NE, SE, S
	Hellula undalis Fabr.	leaf eating caterpillar	CP, N
	Crocidolomia binotalis Zell.	leaf eating caterpillar	N, CP, S, SE
	Pieris cannidia Sparr.	leaf eating caterpillar	N, CP
	Agratis ypsilon Rott.	leaf eating caterpillar	N, CP, SE
	Phyllotreta SPP.	leaf eating beetle	N, CP, NE, SE, S
	Brevicoryne brassicae L.	leaf aphid	N, CP, NE, SE, S
	Lipaphis erysimi Kalt	leaf sucking plant louse	N, CP, NE, SE, S
	Eurydema liturafera Wertw.	leaf sucking plant bug	N, CP

[a]N - northern NE - northeast CP - central plain S - southern SE - southeastern

VEGETABLE PRODUCTION AND MARKETING IN THE PHILIPPINES

Domingo F. Panganiban[+]

Vegetable production in the Philippines today is far from sufficient despite the vast hectarage that is devoted to it. The country needs 4.4 million t of vegetables to satisfy the requirements of its approximately 44 million population, based on the recommended intake of about 100 kg/capita per year.

Table 1 shows the area, production, and yield per hectare from 1971 to 1975. The data indicate that yield per unit area has not progressed much in the last five years.

Table 1. Area and production of vegetable in the Philippines.[a]

Year	Area	Total production	yield
	(1000 ha)	(1000 t)	t/ha
1971	361	1683	4
1972	379	1666	4
1973	392	1698	4
1974	439	1936	4
1975	492	2389	5

[a]Source of data: BAEcon, Vegetables included are beans peas, root crops, onions, garlic, pechay, cabbage, tomato, eggplant, watermelon, and raddish.

The general output per unit area is relatively low and the quality of the production from the farms leaves much to be desired. These conditions have been caused by:

1. Inadequate supply of quality seeds.
2. Poor cultural practices.
3. Excessive insect and disease damage.

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4. Limited knowledge in the post-harvest handling of vegetables.

5. Faulty marketing system.

6. Limited transportation, processing and storage facilities.

7. Inadequate number of trained and dedicated extension workers.

The present thrusts of the government programs in both research and extension have been geared toward minimizing these problems. The *Gulayan sa Kalusugan* (GSK),[++] a commercial vegetable production program which was launched in July 1975 covering 25 provinces and one city, is aimed at increasing yield per unit area through the adoption of a package of recommended technology. It is also directed toward increasing the income of farmers through improved management and marketing schemes.

The GSK covers around 20% of the total area devoted to vegetable production. This area produced approximately 30% of the total vegetables during the crop year 1975-1976. The Green Revolution Project, which caters primarily to production for home consumption to improve nutrition covers a major portion of the total area devoted to vegetable production. However, since this program concentrates on small backyard gardens, its contribution to improved production technology is minimal.

Priority Crops and Regional Adaptability

Beans and peas (fresh and dry) are widely grown throughout the country with a total area of 52,100 ha planted in 1975 (Table 2). However, these are concentrated in the western Visayas and Ilocos regions.

Among the root crops, sweet potato and cassava are extensively cultivated in almost all provinces of the country.

Other priority crops include tomato, cabbage, onion, garlic, white potato, watermelon, and cantaloupe. The production of tomato during the period from July to December has been concentrated in typhoon-free areas, particularly in northern Mindanao. This is to supply the Metro Manila markets during the rainy season in Luzon.

Using F_1 hybrids, cabbage can be planted year-round throughout the Philippines, depending on local demand.

Onion, watermelon, cantaloupe, and garlic production have been generally seasonal in nature. These crops are usually planted after rice. Garlic production has been limited to the Ilocos and the southern Tagalog regions, whereas onions are widely grown in central Luzon, southern Mindanao, the Ilocos, Cagayan Valley, and some provinces in the southern Tagalog region.

Watermelon and cantaloupe have been raised extensively in central Luzon, Ilocos, southern Tagalog, western Visayas, and the Bicol regions.

White potato production has been limited to the high elevations in Benguet and Mountain Province in the north and in the provinces of Bukidnon and north Cotabato in Mindanao.

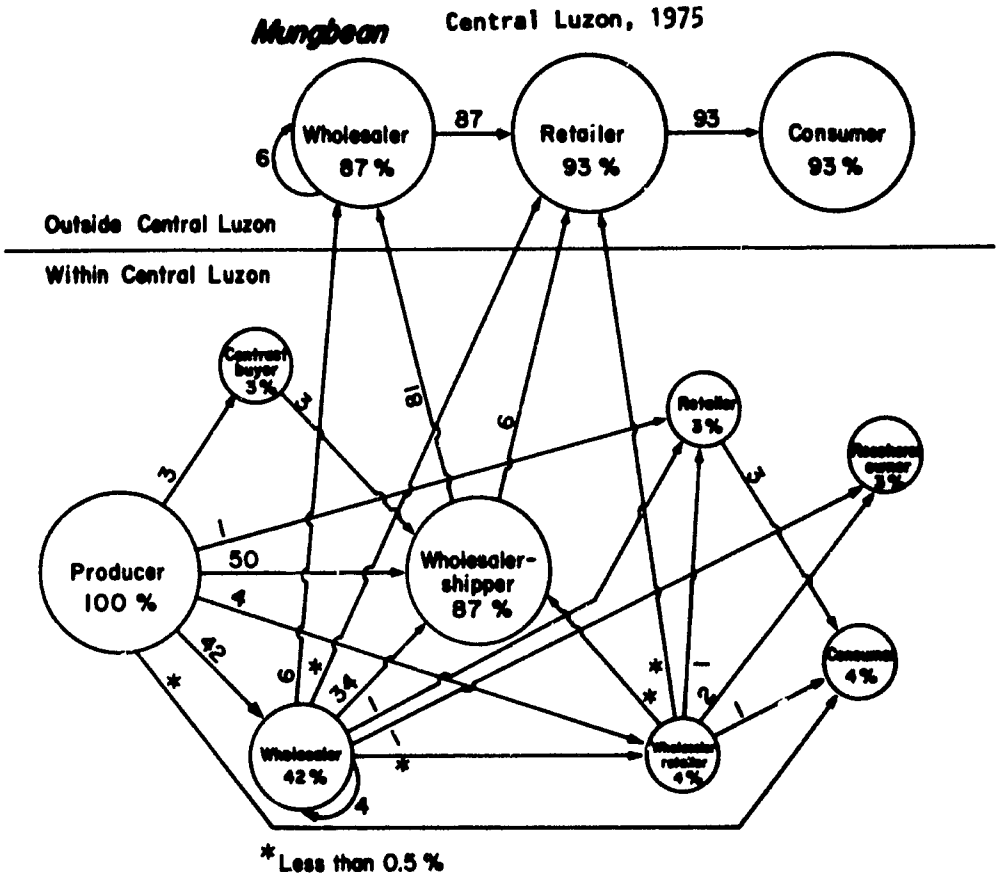
[+]Vegetable Production for Better Health.

Table 2. Area and production of vegetables in the Philippines, 1975.[a]

Vegetable	Area	Production
	(1000 ha)	(1000 t)
Cabbage	8	53
Eggplant	17	85
Garlic	4	16
Pechay	5	37
Radish	2	12
Tomato	19	137
Onion	13	63
Ginger	4	24
White potato	3	20
Dry bean	5	5
Mungbean	39	22
Soybean	8	6
Watermelon	13	101
Total	141	580

[a]BAEcon Crop Statistics, 1975.

A breakdown of individual crop production by region is shown in Figure 1.



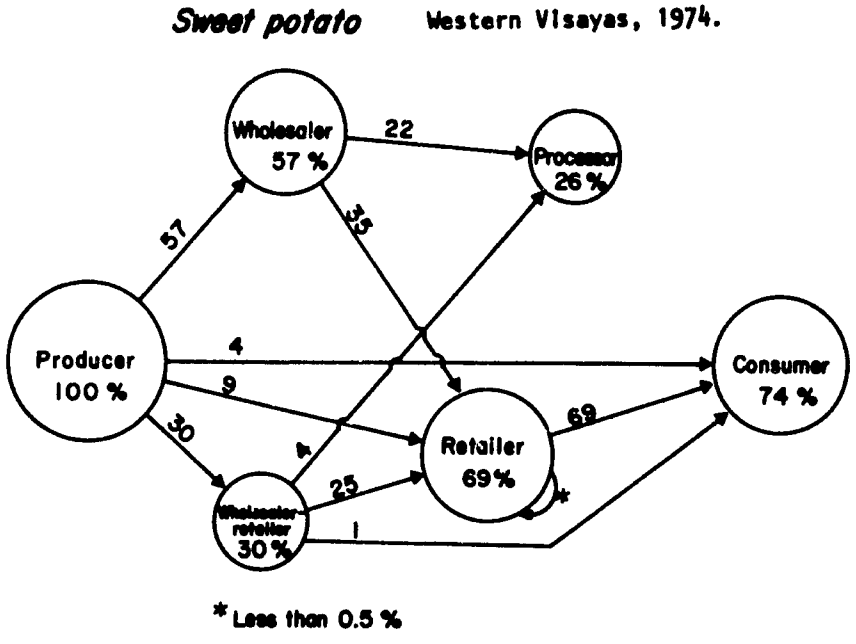
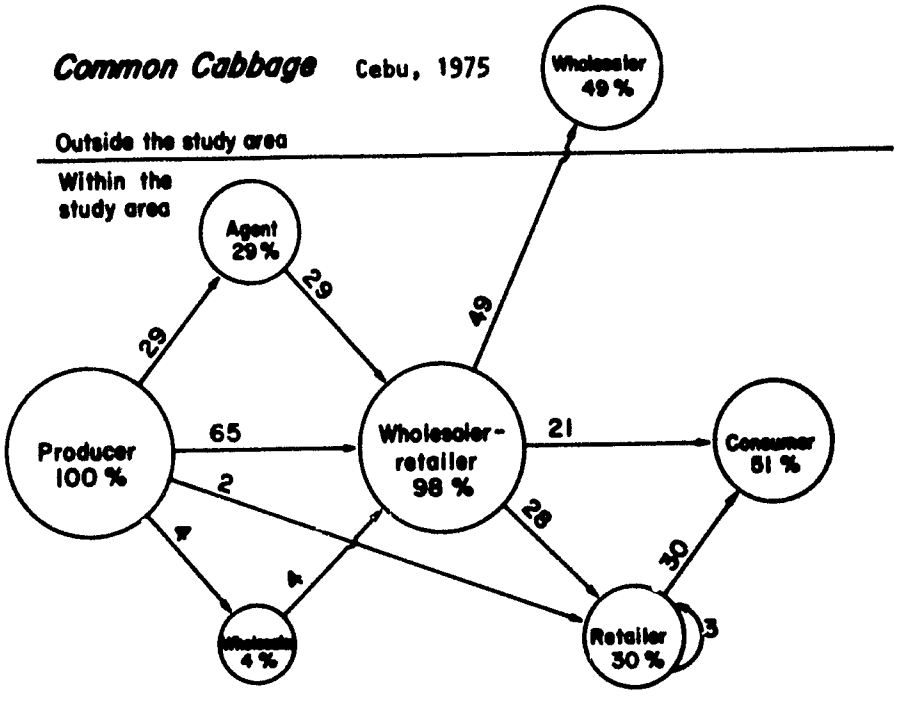
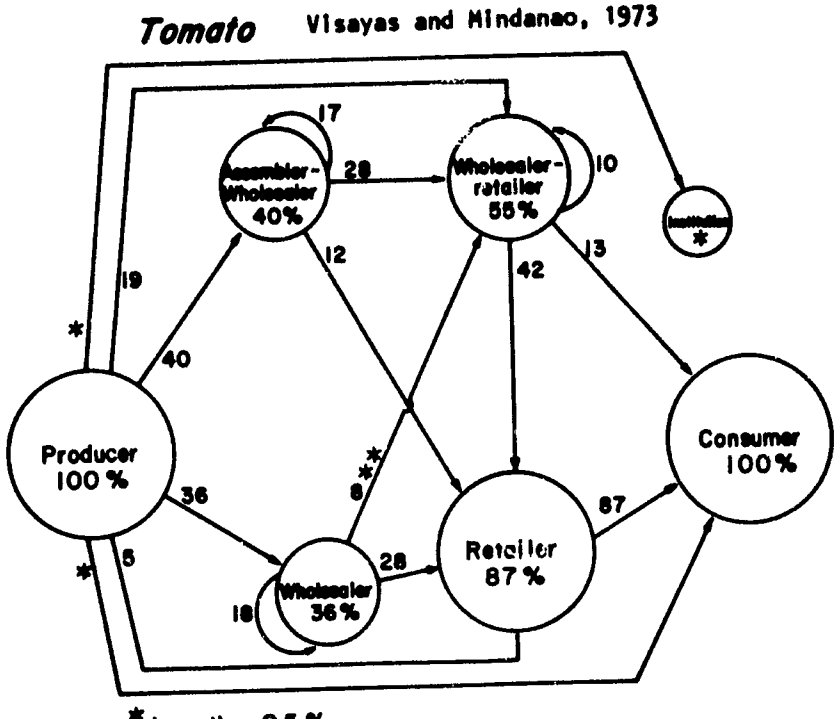


Fig. 1. Market channels for vegetables in the Philippines.





* Less than 0.5 %

** Net flow, meaning there was trade both ways.

Fig. 1. Market channels for vegetables in the Philippines. (Continued)

Limitations to Production

Diamondback moth appears to be the most difficult to control among the pests damaging crucifers. The most serious disease outbreak to-date, was that of the mosaic virus affecting melon in Pampanga. Other serious diseases reported are bacterial wilt, powdery and downy mildew of cucurbits, bean mosaic, late blight, and virus diseases of white potato.

Research should be geared toward the solution of those problems and varietal improvement to increase yield potential and resistance to pests and diseases. An effective mechanism to transfer the technology to the farmers' fields also must be developed and implemented if we are to keep up with the demand of the increasing population.

Marketing Problems

Problems in marketing are interlinked with production. For instance, a very high price during a certain month of the year could trigger overproduction the next year. This is because a number of farmers, without consulting each other would try to schedule their production to take advantage of the expected high price during a particular period. This results in a tendency to produce more than the market can absorb, resulting in a low price for their crops.

A common problem associated not only with vegetable marketing but also with other farm commodities is the unnecessary proliferation of marketing channels. Studies conducted by the Special Studies Division of the Department of Agriculture revealed that the product from the farm has to pass through 5 to 6 channels before it reaches the end-user. This has increased the marketing costs considerably to the detriment of both the producer and the consumer.

Figure 1 offers a graphic illustration of the numerous channels that a particular commodity has to pass through.

Another problem is seasonality of production. Since most of these crops are perishable, prices tend to be at their lowest during the peak of the harvest season. This is also related to availability of transport facilities and the proximity of the production area to the markets.

The quality of produce is conditioned by the level of production technology and the post-harvest handling techniques that have been applied from the farm until produce reaches the end-user or consumer. Distance from farm to market is again a relevant factor to consider.

Producers have depended on bamboo baskets *kaing* for packing vegetables like, cabbage, chayote, and other vegetables for quite some time. It is expected that bamboo will no longer be cheap and available as it is used for furniture and other cottage industries. Hence, we need to test and find out alternative packaging materials and designs to lessen the extent of spoilage and damage of the produce while in transit or in storage.

Still another marketing problem is the difficulty in assisting individual farmers in selling their produce due to the lack of a government agency to perform this function. However, efforts are being made to organize the farmers and encourage them to form marketing linkages with

traders, processers, and exporters. In the process, production schedules and targets can be based on the needs of these identified outlets.

In view of regional differences, production and marketing schemes should be localized to make them more responsive to the needs of a particular area. Experiment stations in every region should include marketing and extension specialists in addition to the present production specialists to conduct socioeconomic and marketing studies for the region. After all production and marketing are like man and woman; one is useless without the other.

VEGETABLE PRODUCTION AND MARKETING IN KOREA

Chung-il Choi[+]

Korea is in the temperature zone. The mean temperatures are above 25°C during August and below 0°C in January except in the southern coastal regions. Annual accumulative sunshine varies from 2000 to 2500 hr. Annual precipitation ranges from 1000 to 1300 mm, two-thirds of which is concentrated during the hot season from late June to mid-September. Unseasonably early or late frost in late April and early October is one of the main limiting factors for vegetable production in Korea.

The farm population is approximately 38% of the total population of 35 million. The average farm household of 5.6 members has 0.94 ha of farm land. Most of the farmers are engaged in rice production on paddy fields and the average rate of land utilization in 1975 was 141%.

Over 96,000 power tillers were in use in 1975. The annual consumption of chemical fertilizers was about 1,000,000 t and that of pesticides was about 20,000 t.

The major agricultural products are food grains, vegetables, fruits, and livestock. The production of food grains was 7 million t, while that of vegetable was 3 million t in 1974. The 276,000 ha of land used for vegetables is about 8.7% of the 3,166,000 ha cultivated annually (Table 1).

The four major vegetable crops are Chinese cabbage, radish, chili pepper, and garlic. These vegetables are used primarily in making kimchi, a partially fermented product which can be stored for long periods. Korean vegetable production is unique because of the special consumption pattern represented by kimchi.

VEGETABLE PRODUCTION RESEARCH

Research on the vegetable crops in Korea was first initiated with the establishment of the Horticultural Experiment Station in 1950. As a first step, seed production technology was developed and new varieties for domestic consumption were bred. By 1957, self-sufficiency in local seed production was attained. Some 6 million liters of vegetable seed no longer had to be imported.

During the period 1960 to 1962, 4 F_1 varieties of common cabbage, Chinese cabbage, and onion were released to farmers through commercial seed companies. They had been bred at the Horticultural Experiment Station using self-incompatibility systems in common cabbage and Chinese cabbage and male sterility in onion.

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Table 1. Area, production, and yield of vegetables in Korea, 1976.

Item	Area	Total production	Yield
	(1000 ha)	(1000 t)	(t/ha)
Chinese cabbage	70	895	14
Common cabbage	2	48	23
Spinach	3	30	11
Garlic	17	95	6
Ginger	1	7	8
Onion	5	123	26
Welsh onion	7	100	14
Radish	67	903	13
Carrot	1	9	10
Tomato	3	60	18
Chili pepper	53	101	2
Eggplant	3	37	14
Cucumber	9	129	15
Squash	11	170	16
Watermelon	8	178	21
Strawberry	2	20	9
Oriental melon	10	120	12
White potato	53	675	13
Sweet potato	95	1953	21
Soybean	247	354	1
Mungbean	8	6	1
Beans	3	2	1
Peas	2	2	1
Total	680		6017

With the release of these F_1 hybrids the commercial seed companies became responsible for the establishment of research farms and employed scientists from the Horticultural Experiment Station to develop the seed industry. By 1976, 26 seed companies were producing vegetable seed and over 364 thousand liters of vegetable seed were exported. Ten major companies have produced some 311 varieties, 78% of which are F_1 hybrids.

The production of virus-free potato seed was initiated in the Daekwanryong Mountain area in 1959. The potato breeding program is now rady to identify selections among the introduced varieties make crosses using lines from many parts of the world obtained with the cooperation of the International Potato Center in Lima, Peru. New methods for rapid production and release of virus-free seeds are being introduced.

Strawberry, a labor intensive crop, and garlic are also being studied to develop practical methods of utilizing virus-free stocks produced by shoot-tip culture. In the case of strawberry, cultivars for processing are of major interest.

The Horticultural Experiment Station has cooperated with faculty members working in 19 Colleges of Agriculture in Korea in conducting studies on physiological problems of vegetable cultivation.

Recently, Korean olericulturists began to pay more attention to setting up year-round production systems for several vegetable crops. Breeding of heat tolerant varieties and developing cultural methods applicable in mountainous areas are also being pursued.

Vegetable Production in A Developing Context

Owing to the successful economic development programs which began in the early sixties, the national gross income per capita of Korea increased rapidly to almost $700 in 1976.

The optimum annual consumption of vegetables is estimated to be 150 kg/person. The present production of 66/person can be expected to increase in accordance with income growth. Because the average yield in farmers' fields in only 20 to 50% of the yield on research farms, methods to increase the total production should be sought from the viewpoint of increased yield rather than increased area.

Vegetables essential for kimchi, e.g., radish, Chinese cabbage, chili pepper, and garlic are still major items in Korea and constitute 67% of total vegetable production and 74% of total area. After kimchi is made in late autumn, it is usually preserved to serve every day until mid or late spring when fresh leafy vegetables reach the market. In part becasue of difficulties in preservation and decreasing freshness and in part because of developing technology to increase production of 'off-season' vegetables, the consumption of kimchi for long-period preservation is declining. Hence, year-round production of other vegetables will be emphasized and the consumption of vegetables other than those for kimchi is expected to increase.

The consumption of processed products such as jam, juice, and catsup is expected to increase in accordance with economic growth. For example,

905 t of tomato and 515 t of strawberry were processed in 1975 but the supply is not stable.

To meet the changing trend of consumption, intensive studies should be carried out on the following subjects:

1. Develop systems for year-round production of traditional vegetables such as Chinese cabbage, radish, garlic, chili pepper, and cucumber.

2. Increasing production of cauliflower, broccoli, and celery.

3. Breed for processing, and mechanization of cultural practices.

Cropping Systems

Weather conditions such as hot summers and cold winters restrict the diversification of double and triple cropping systems in Korea. Only a very limited choice of crops is available for double cropping under these climatic conditions.

The cropping systems in Korea are mainly classified into two categories: (i) paddy field systems for production of rice and barley, and (ii) upland areas for most other crops (Table 2). The rice-barley system covers more than 90% of double-cropped paddy area (about 555,000 ha); and onion, garlic, potato, and other vegetable crops are grown before or after rice and occupy 34,000 ha or 6%. In upland fields, the barley-legume system covers more than 42% of the total area. Vegetable-vegetable and barley-sweet potato also comprise important upland double cropping systems (Table 3).

Table 2. Paddy field double cropping systems in Korea.

Cropping system	Area	(%)	Location
	(1000 ha)		
Rice - barley	502	90	Southern area
Rice - onion or garlic	10	2	Southern area
Rice - white potato	9	2	Whole country
Rice - other vegetables	15	3	Southern area
Rice - tobacco	10	2	Southern area
Rice - industrial crops	5	1	Southern area
Rice - others	4	<1	Northern area
Total	555	100	

Table 3. Upland double cropping systems in Korea.

Cropping system	Area	(%)	Location
	(1000 ha)		
Barley - legume	345	43	Whole country
Barley - sweet potato	111	14	Southern area
Barley - other grains	26	3	Whole country
Barley - vegetable	26	3	Whole country
Barley - others	39	5	Whole country
White potato - vegetable	19	2	Whole country
White potato-legume	14	2	Whole country
Vegetable - vegetable	130	16	Whole country
Single crop of vegetables	81	10	Whole country
Others	20	2	Whole country
Total	811	100	

The main vegetable cropping systems are frame-culture of various vegetables before paddy, fruit, leafy, or root vegetables, and single cropping of chili pepper, eggplant, or squash on uplands. Vegetables planted in paddy fields before rice are lettuce, leafy crysanthemum, and spinach in the North and cucumber, melon, tomato, watermelon, radish, and Chinese cabbage in the South (Fig. 1 & 2).

There are several reasons why additional cropping systems have not been developed in Korea: (i) the growth period for rice cannot be altered because of low temperature and insufficient water. (ii) irrigation systems are not available to provide a regular supply of water to upland areas, and (iii) no vegetables can be grown in the winter without protection from freezing temperatures.

Pre-Harvest Technology

In Korea, where the frost-free period is 170 to 200 days, temperature is the most important environmental factor limiting vegetable production. Because summers are hot and winters are cold, there are only two seasons, spring and fall, in which vegetables can be grown under optimum temperatures of 15 to 20°C. To overcome this handicap, specialized technical skills have been developed. One is growing seedlings on hot beds during late winter for spring culture. Another is growing Chinese cabbage seedlings in pots for transplanting without root damage which may limit growth and maturation during the restricted growing period.

When growing vegetables for commercial production, farmers use nitrogen, phosphate, and potassium fertilizers. They also apply lime,

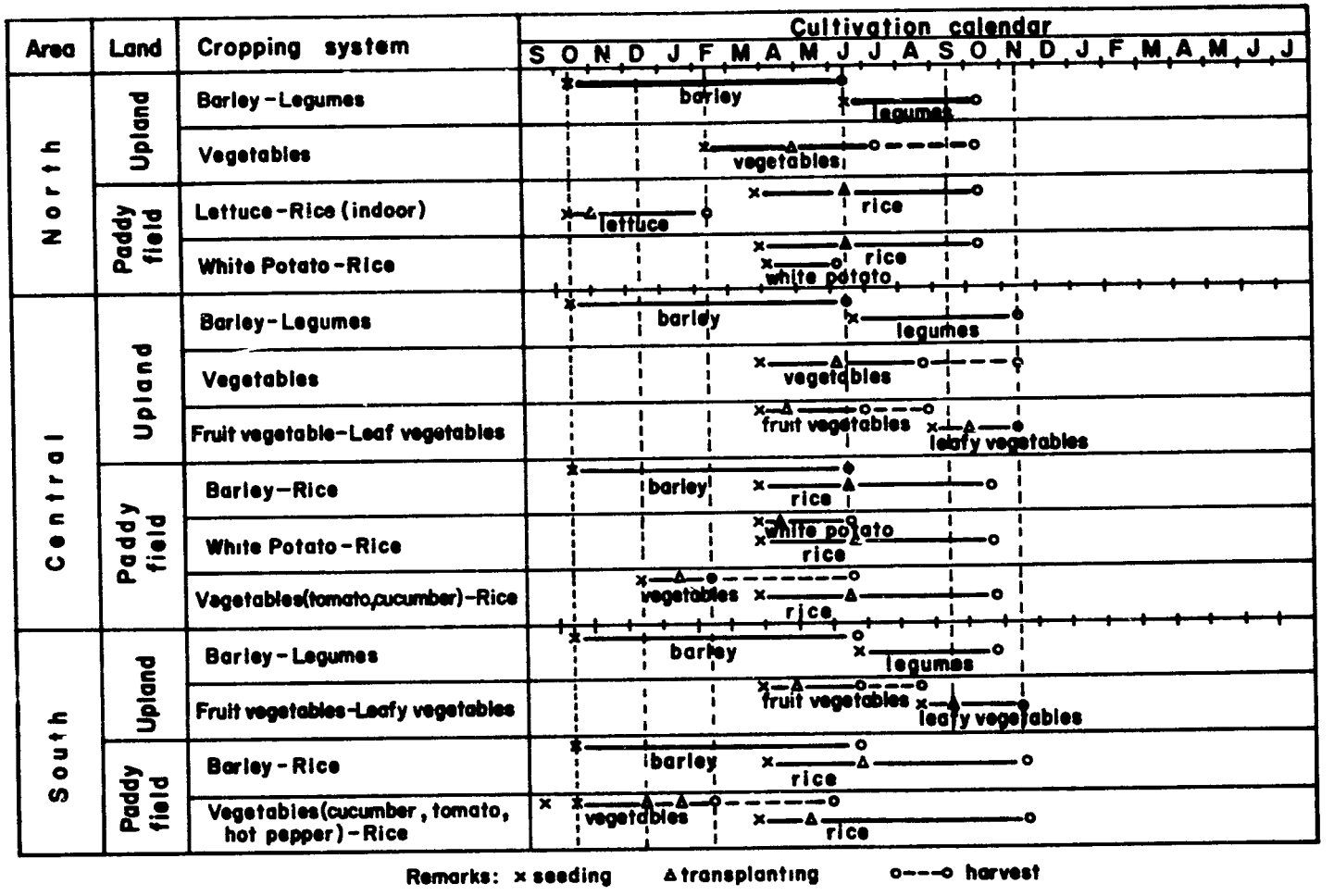

Figure 1. Cropping systems in Korea.

Crops	Culture patterns	Cultivation calendar[a] J F M A M J J A S O N D	Remarks
Chinese cabbage & radish	Spring		whole country
	Summer		alpine area
	Fall		whole country
	Forcing		southern part
Red pepper	Spring		whole country
	Forcing		southern part
Tomato	Spring		whole country
	Forcing		southern part
Cucumber	Spring		whole country
	Summer		whole country
	Forcing		southern part
	Semi-forcing		southern part
Squash	Spring		whole country
	Forcing		southern part
Watermelon	Spring		whole country
	Forcing		southern part
Garlic	Fall		whole country
Onion	Fall		southern part
Carrot	Spring		whole country
	Fall		whole country

[a] x = sowing Δ = transplanting o——o = harvest

Fig. 2. Growing pattern of vegetables in Korea.

boron, and compost in proper quantities to protect the crops from nutritional and physiological disorders. Yet vegetable farmers often disregard recommended rates of fertilizer application.

Most farmers know that irrigation is very important in vegetable growing; however, irrigation is not common in Korea because most upland areas are located in hilly regions that are far from water sources.

Insecticides and fungicides are used effectively to control pests and diseases attacking vegetables. However, to control insects and diseases at lower costs, more attention must be given to the introduction of well-developed forecasting systems and integrated control methods.

To meet the growing labor shortage in the rural areas, continuous efforts are needed to develop various measures to reduce labor costs. Power tillers, speed sprayers, and irrigation pumps are now available for vegetable farming. Herbicide application is also recommended as a means to reduce the requirement for labor.

Frame culture (growing crops in plastic film houses during the winter), and alpine growing during the summer for off-season production of vegetables are examples of improved cultural techniques employed in Korea to expand vegetable production. But not enough attention has been given yet to problems of CO_2 gas supply, moisture control, and high temperature injury in the plastic film houses.

Post-Harvest Technology

Most Koreans use kimchi made from Chinese cabbage, radish, chili peppers, and garlic bulbs as their main source of vegetables during the winter season. Some housewives prepare dried vegetables from peppers, young squash, eggplant, radish, and the roots of bellflowers. They also pickle cucumbers, green peppers, radish, shallot and other vegetables.

Recently, commercial processing of strawberries and tomatoes was introduced to make jam, juice, and nectar. Freezing techniques have also been used to store strawberries and spinach on an industrial scale. Irradiation and chemical sprays, MH-30 and CIPC, are now being tested to improve garlic, onion, and potato storage during the winter.

The Ministry of Agriculture and Fishery and farmers' associations have made efforts to provide the financial and technial support necessary to develop processing and storage industries. Scientists working in agricultural colleges have been devoting themselves to basic and applied research related to post-harvest technology.

Marketing of Vegetables

Marketing of vegetable crops in Korea can be classified into two categories; one via agricultural cooperatives and the other through brokers. The paths from farmers to consumer involve 4 to 6 steps (Fig. 3). The channel via agricultural cooperatives is the simplest, although the amount handled in this manner is quite small.

Wholesalers and retailers added on an average margin for vegetable produce in 1974 ranging from 13% to 142% (Table 4). The margin was re-

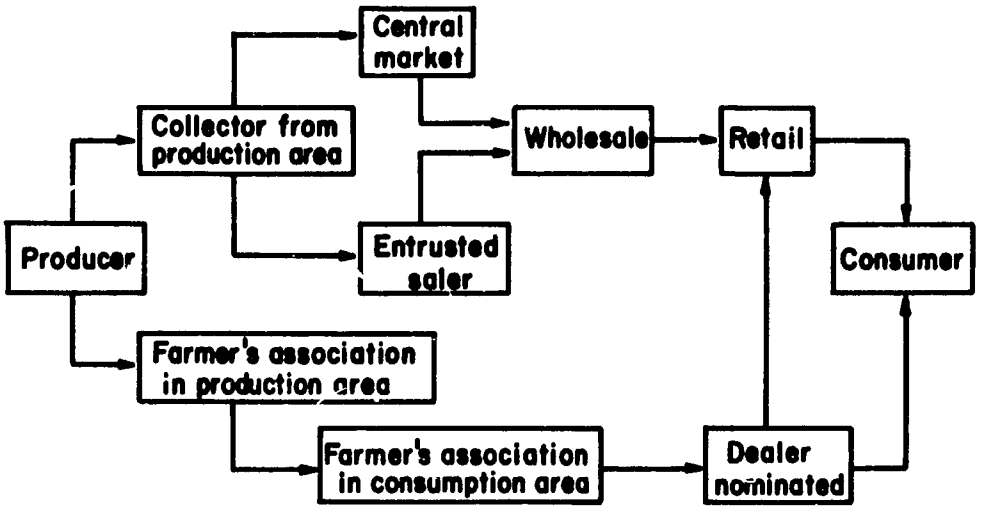

Figure 3. Marketing patterns for vegetables in korea.

Table 4 Estimated margins added to farm prices of vegetables (1974) in Korea.

Crop	Margin added to farm price		
	wholesalers	retailers	total increase
	(% of farm price)		
Lettuce	71	71	142
Chinese cabbage	49	18	67
Cucumber			51
Radish	26	19	44
Welsh onion	18	22	40
Sweet potato	17	21	38
Tomato			35
White potato	18	16	34
Oriental melon	17	16	33
Chili pepper			21
Garlic			19
Watermelon		16	16
Carrot		14	14
Onion		13	13

latively high for radish, Chinese cabbage, and other vegetables which are cultivated mainly for on-farm consumption. On the other hand, it was comparatively low for cash crops such as onion, garlic, and chili pepper.

The major problem in marketing vegetable crops is the extreme seasonal fluctuation in market prices (Table 5). High margins result in overpayment by consumers and at the same time in loss of profit for the farmers involved. Farmers cannot easily overcome the problems because:

1. Vegetable production in terms of both area and production per farm is very small.

2. Market information is not available.

3. Capital for investment is insufficient.

Table 5. Monthly market price of vegetables (1975, Seoul, Korea).

Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	(US$/100 kg)											
Chinese cabbage	4	7	7	11	8	9	8	15	15	9	10	6
Radish	5	7	6	6	10	7	6	5	10	7	4	4
Onion	18	26	23	28	24	14	15	16	19	32	36	39
Carrot	13	15	14	19	30	30	28	42	55	33	21	19
Welsh onion	9	11	11	7	10	13	13	15	14	16	16	15
Garlic[a]	45	72	100	81	75	90	136	144	144	178	198	318
Chili pepper	41	44	48	45	45	51	48	35	45	42	39	36
Tomato				77	66	34	13					
Cucumber	120	71	81	37	32	13	12	12	24	41	60	81
Lettuce	33	33	28	27	17	11	29	56	32	60	27	12

[a]US$/1000 bulbs.

To solve these problems, it would be desirable to establish main production areas for each vegetable crop and for farmers within the areas to organize into cooperative associations. This should permit farmers to take the initiative in marketing their products. Annual and seasonal control of production is also possible by providing financial support, technical assistance, and market information through the associations.

Enlargement of the facilities for processing and storage of vegetable products would contribute greatly to the maintenance of stable prices at reasonable levels.

GAPS IN RESEARCH KNOWLEDGE AND CAPABILITIES

GROUP I SOUTH ASIA

Discussion Leader: Prof. Y.D.A. Senanayake
Member: Mr. Abdul Razzaque
Mr. D. R. Pandey
Mrs. Somporn Drabyasara
Dr. Anothai Chomsaai
Mr. Pritana Pradipasen

CONSUMPTION PATTERNS

Information on general consumption patterns is already available in many countries.

In Sri Lanka, detailed information on consumption and expense for each vegetable crop is available in relation to income groups.

Information from other countries is also required for production planning in relation to projected increases of population, local consumption, exports, and processing.

PRODUCTION TECHNOLOGY

Agroclimatology

Detailed studies on agroclimatology were not considered necessary. Any problems arising from agroclimatic factors could be overcome by evaluating vegetables in the network stations according to different agroclimatic areas. In addition, evaluation trials could be extended to farmers' fields.

Nepal does not have the capability for this type of evaluation. Sri Lanka and Bangladesh also have insufficient research staff or organization for these investigations.

Breeding

It was felt that breeding for adaptability and evaluation of growth and yield performance under agroclimatic zones could also help in overcoming the problems associated with agroclimatology.

Furthermore, if new vegetables are identified for further study, the next step would be to determine whether AVRDC could initiate these studies.

If this is not possible, an effort should be made to concentrate on the development of these new vegetable crops in different countries in the network, as in the Institute of Plant Breeding of the University of the Philippines at Los Baños and other institutions. It was pointed out, however, that resources should be available for refined work, germplasm collection, evaluation, and storage of germplasm and similar undertakings if a country should accept the breeding work on a particular vegetable crop.

The group members also pointed out that a country may already be working on a specific problem. For example, Thailand is working on the problems of curley leaf virus complex of the *Capsicum* type of chilies. Numerous accessions have been collected and screened for resistance. These materials are used in breeding for resistance. Curley leaf is a serious problem also in Sri Lanka, Bangladesh, and, perhaps, in other countries. Therefore, the network could assist Thailand's program instead of duplicating it elsewhere. Such work should be identified from the results of the survey.

FIELD MANAGEMENT

Fertilizer and other Agrochemicals

Gaps exist in all countries in knowledge of fertilizer and agrochemicals. The cost of these inputs keeps on escalating and, therefore, work on the rational use of fertilizer is an urgent need. It was also felt that research should be conducted to reduce the field time of a crop by extending the nursery management stage. Such research could also reduce field input costs and bring cost relief to the farmer. An added advantage is the use of the same field for another cropping cycle which would increase the intensity of land use.

Water Management

Attention was focused on the problem of vegetable growing in the dry season in all countries. The peasants of the region have urged the priority need for the development of irrigation facilities in the dry areas. As one contribution, the group agreed studies should be made to determine the optimum water requirement of major vegetable crops so that irrigation water need not be wasted. This could help make irrigation service available to more farmers in that area.

Cropping Systems

Cropping system were recognized as a problem in all countries. The results of studies that are already being made and the others that will follow will have to be disseminated in the network. Research on different cropping systems using vegetables or vegetables in combination or rotation with other crops is urgently required to improve farm income, diversify production, and intensify land use.

POST-HARVEST TECHNOLOGY

Processing

The consensus was that an intermediate technology would be more suitable for development at this stage for countries in Asia because capital intensive processing plants which already exist are unable to obtain adequate supplies to meet contractual obligations. If pre-harvest vegetable technology could boost the output of vegetables, this could help these existing plants to process more efficiently and run their facilities nearer their maximum capacity.

But the participants felt that simple methods of preservation could also be used, like sundrying, to develop marketable vegetable products. Other existing forms of traditional processing that can be

examined include the preparation of chutneys, pickles, and preserves. Research would be conducted to develop labot intensive but refined processed products which could be marketed locally and abroad. Research in these areas as well as in marketing were recognized.

Marketing

A wide-spectrum problem that awaits solution is that of packing materials, handling, containerization, stocking for transport, and storage. A wide knowledge gap exists which could be filled before alternatives can be recommended. Although the problem is common to countries in the group, their solutions could vary. Assistance in seeking and sharing information on alternatives would speed solutions.

Detailed studies on the costs of marketing at each stage of the marketing channel and loss of produce are needed. They should be updated regularly. Since there is a knowledge gap here, it is not possible to identify the weakest links in the marketing chain that, perhaps, could be corrected without difficulty.

A few countries publicize market prices through different media, such as newsletters, daily newspapers, and radios, but no studies have been made to determine their effectiveness in helping the farmers obtain better prices.

INFRASTRUCTURE

The group felt that all efforts to improve pre-harvest technology could fail to achieve the desired results if the farmer could not purchase his requirements in time for want of finance. There may be gaps in knowledge in some countries or in the credit needs of the farmer. The knowledge should be made available and the credit schemes should be made more effective.

GAPS IN RESEARCH KNOWLEDGE AND CAPABILITIES

GROUP II: EAST ASIA

Discussion Leader: Peter H. Calkins
Members: Dr. Chung-il Choi
Dr. Sadao Nishi
Dr. Chin-fung Li
Mr. Enriqueta B. Torres
Dr. Danilo Isada
Dr. Masman Bekti
Mr. Hansani Pekerti

The following is a summary of the East Asia Discussion Group's conclusions on the major gaps in research knowledge and capabilities. The major problem areas are:

1. Production technology.
2. Post harvest.
3. Marketing.
4. Infrastructure.
5. Institutions.
6. Consumers.

MAJOR PROBLEMS IN EACH COUNTRY

Korea: Price fluctuation and marketing: farmers cannot depend on adequate price for their produce.

Japan: Production technology such as low fertility, disease and shortage of labor.

Taiwan: Land and labor.

Philippines: Marketing and post-harvest handling.

Indonesia: Consumer: problem is basic nutritional status. Certain sectors are not able to buy enough vegetables to support their health.

CROPS INVOLVED IN HELPING SOLVE THE PROBLEMS

Korea: White potato, tomato, strawberry.

Japan: Cabbage, tomato, lettuce.

Taiwan: Chinese cabbage, mungbean, white potato.

Philippines: Cabbage, tomato, other leafy vegetables, beans.

Indonesia: Kangkong, green beans, cabbage.

Many crops listed are the same, but the specific problem area for each crop in each country may be different. Therefore, problems of specific research within a crop may be apportioned among the participating countries.

Suggested Areas of Cooperation

Limited reserves of manpower must be trained to tackle the most impotant problems. It is also essential to upgrade the quality of manpower.

It should be possible to entrust a particular research problem to one country. But there are, of course, two kinds of researchers: basic and applied. It seems wise to share basic research but to conduct applied research on a national level.

Examples of Specific Problems

Crops

Common cabbage - *Plutella* (diamond back moth).

Tomato - how to retain more solid content when processing.

- low cost technology for drying tomato.

Infrastructure

Irrigation water is the biggest problem, especially during the dry season.

Consumers

There is not enough consumer education in the countries involved. For example, in the Philippines, lack of knowledge about nutrition results in insufficient demand for vegetables.

Major Outcomes of the Discussion

1. Specific problems need to be limited to a manageable number of crops.

2. Detailed data will be necessary for each problem in a crop's development.

3. An interdisciplinary approach must be used.

4. There must be a strong campaign to increase nutritional knowledge.

A CRITICAL ANALYSIS AND OVERVIEW OF THE VEGETABLE INDUSTRY IN ASIA

James C. Moomaw+

I have been asked to give a critical analysis and overview of the work that has been accomplished in the past two and one-half days. Although I am not an economist, I think there are some things we can pull together from the papers by simply listing the areas that have been described as unparalleled opportunities disguised as insurmountable problems.

I would like to focus our attention on solutions to these problems which you have identified. Later in the seminar we are going to be more concerned with techniques, but there are a few clear priorities that have come out of the proceedings so far. First, we want to focus on the farmer - the man who is the producer. We want also to see that the consumer is reached as well.

We have had representative papers from 11 countries, including Hawaii, and the recent remarks on the Korean situation by Dr. Choi. We can list five areas that these papers covered. They are not clearly separate and some papers deal with many of them while some deal with only one or two. The topics are:

1. Production technology
2. Post-harvest technology
3. Marketing
4. Infrastructure
5. Institutions

In addition to the papers, we have the five trial forms to examine on (1) research needs; (2) data on crops, specific practices, and information; (3) manpower; (4) the producer's situation in production and marketing; and (5) post-harvest handling and distribution.

In preparation for this seminar, some of you may have read the volume produced by the Agricultural Development Council called "Some Studies of Fresh Fruit and Vegetable Marketing in Asia," edited by Herman Southworth in 1974. It is the proceedings of a meeting in 1972 held at Gadjah Mada University in Yogyakarta.

Two studies are reported here, one about marketing in Hongkong and one referring to the marketing of cabbage and other vegetables from Sumatra to Singapore markets. The paper on "Cabbage Marketing Problems in West Malaysia" refers mainly to the import from the producing areas in Sumatra. It brings the international marketing of fresh vegetables into

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focus, which is something we have not touched on much here. Some quite intense competitive situations arise in this case. The Government of Singapore is very much interested in substituting local production for those imports and yet Sumatra has based natural advantages for producing vegetables for the Singapore market. It makes the institutional point that policy consideration within national boundaries strongly affect the marketing of vegetables. We might discuss this point at length later on.

Another paper describes the Metropolitan Marketing Organization in Hongkong which was organized originally to provide an outlet for vegetable farmers with direct access to Metropolitan Hongkong from the New Territories or other locations where middlemen were said to be taking advantage of the farmer. It is an example of an organization created to function as a competitor to the private enterprise middlemen. The paper states that, within a few years, the bureaucracy of the Metropolitan Marketing Organization grew to such a point that it became much less efficient than the private enterprise marketing system and that many farmers went back to the traditional system. The private system survived because it was an efficient and simple marketing system in spite of the fact that the farmers did not get the best price; the farmers did not have to fill up the forms and make contributions to the local firemen's ball or other things that go into some bureaucratic procedures.

Also relevant to the point are Dr. Senenayake's diagrams of marketing in Sri Lanka. It shows that private channels survive. They are operating side by side with a very strong and a very well organized government system. So this, in part, reflects the complexity of vegetable crop production and marketing. Many different kinds of vegetables, so many different markets and so many different farmers are involved that, perhaps, one system is not sufficient to deal with them all.

I would like now to discuss these problems starting with production technology. Many of the papers make quite a point of the environmental factor in production technology. This is the first problem. It is a difficult problem. There are spatial variations in soil qualities that are characteristic of each of the countries represented here. They are all different and the complexity of the ecology in each of the regions is, of course, well known.

In Asia, the general pattern of seasonal rainfall is an alternation of wet and dry seasons. In some countries such as Bangladesh, Taiwan, and even in northern Thailand, there is a pronounced cool season. In Japan and Korea, the winter is extremely cool, making it impossible to grow things without protection, as Dr. Nishi pointed out. But within the general pattern are evident solutions. One of them is the complementarity of production patterns. This may help the farmer to only a small degree, but it is certainly important to the processing industry.

Dr. Li's table shows that (to oversimplify it greatly) fruits are produced in the summer season and vegetables during the winter. Both are fresh produce that are either marketed directly or processed. In most of the countries represented here, these opportunities exist. They are not only opportunities, it is probably necessary that we have complementary production so the processing industry has products to keep its production lines busy year-round. This, in turn, helps expand markets for farmers while reducing costs to the consumer. Processing requires capital investment, and a successful investment must be kept working as

nearly year-round as possible. Thus, the solution to seasonal variation may be complementary or at least production of a variety of crops.

Another solution to environmental variability, of course, is breeding for adaptability of crops to the summer season. This is a major understaking at AVRDC. It is a major undertaking in the research organizations in each country. We are seeking to develop cultivars that are adapted to high temperatures and that tolerate high rainfall. We are also trying to develop the typhoon-resistant tomato; which will probably be like the search for the Holy Grail, but we can approach it. What we can do, as we make progress, is to lengthen the season of production and move stepwise toward lengthening the season of tomato production into the wet season. This functions somewhat in the same way as the complementarity scheme.

The soils are varied in the tropics so soil fertility problems vary, too. There is no way of producing vegetables, which are generally high users of soil nutrients, without improving soil fertility from some source. In many cases, texture, structure, and other things have to be improved as well as the fertility. I am a little distressed sometimes when I see fertilizer recommendations for the application of 30 t of stable manure in countries where there are no stables.

There is also a problem associated with the recommendation for compost. Compost is, in some countries, a luxury commodity because all the organic residues have a cash value. They are used for fuel and housing. Sometimes, there is a market for paper, rice straw, and other waste materials, which are competitive with use for compost, making the production of compost expensive. Therefore, we do not always have a very good opportunity for producing organic fertilizer on the farm to put into intensive production. Much of it must still come from chemical fertilizers or from inorganic sources.

Phosphorus is chronically short in tropical soils and compost will not supply phosphorus. There is a very low level of recycling available. Whenever possible, of course, the nutrients removed from the land should be put back. That is conservation, not add tion. This is one of the things we must increasingly encourage if at all possible: to conserve nutrients.

One other thing that offers a solution to the seasonal variation problem is, of course, irrigation. Some countries are making rapid progress in the supply of irrigation to relieve stress during the dry season. Mr. Pritana pointed out that with irrigated systems in northern Thailand, there has been a five-fold increase in garlic production in 10 years and that most of these systems that involved vegetables, especially tomato, are high value systems. They give good returns to farm production. Irrigation comes under the infrastructure topic but it is also a production input. And it compensates for a deficiency in the natural environment.

In some cases, even when the environment is favorable, yields are still very low. This is a general production problem. Yields in Indonesia, and the yields that Mr. Razzaque presented from Bangladesh, showed that there was only 50% increase in yield between the wet season (which in those countries is extremely wet) and the dry season, which is relatively favorable for vegetable production. What this means is that it is not so much a wet season problem as it is one of increasing the yield

of vegetables in the favorable season. There is still an enormous amount of production technology waiting to be applied to vegetables in many of these situations that have favorable environments. Some progress is being made in that direction. I am encouraged and heartened by the reports of favorable results.

Some of you have made use of plant materials that have come from AVRDC and we hope that others from the national programs will do equally well. These new materials must be combined with local production technology in most cases.

Field management is another topic that was discussed at some length. Pest control is a major objective of field management. There are generally only two solutions: plant resistance and chemcial control. Pest control techniques are being improved.

The question of seed production has come up repeatedly. I think almost every paper has pointed to this as a major limitation. Professor Somporn's paper showed the very high level of seed imports into Thailand at high cost. Large amounts of foreign exchange are being expended. But let us not be naive about the difficulty of providing quality seeds to the farmer. The international trade in vegetable seed is a highly complex system. There are vast resources of economic power and technology available to private industry in this area.

It may be virtually impossible in some cases to duplicate in a national research and production system what commercial firms are now doing for farmers. For instance, a Japanese seed company may contract for carrot seed production in Oregon. Hundreds of tons of carrot seeds may be produced, say in Oregon, and shipped in cold storage from Portland to Tokyo, repacked in 10-g seed packet and distributed as Japanese seeds around the world. The Japanese facilities are technically very good. Their investment is very high and the quality of their product is maintained by the application of that technology. A Dutch firm is contracting for vegetable seed production in Taiwan. They will produce those seeds in large quantities and ship them in cold storage containers under low humidity to Rotterdam where they are marketed in Holland as Dutch seed. Some of the seed may be shipped back again to Asia after repacking.

The system is extremely complex. The methods are highly technical and the economic resources at their disposal are large. There are Filipino scientists working in New York for seed companies who know not only seed production technology but also the ecology and the problems of vegetable production in Asia.

If we are going to start a national seed production program, let us make sure that our standards are as high as those of the present commercial producers. If we are going to meet the needs of the farmer, we must be able to keep the cost low and the quality high. We do, if possible, want to produce open pollinated varieties that the farmers can use year after year. This is one of the goals of AVRDC and, I believe, of most national programs.

One other complex issue that has been raised is that of processing vegetables. Dr. Li has shown us many machines and techniques that apply to post-harvest technology of vegetable crops. Some of them are extremely capital intensive. They also require highly skilled people, and a high level of management and information.

The freeze-drying, quick-freezing, and air-blast techniques may be too complex for many of our small farmers and the best early techniques are probably the fairly simple drying, pickling, and in some cases, canning processes. Canning is not always complicated but it does require an investment in plant equipment. We must start, I believe, with solar drying and, if possible, some of the pickling techniques that can be applied at the village or farm level.

To discuss marketing just briefly, I think the role of the infrastructure in marketing has been clearly stated by Dr. Torres, and again, by Dr. Senanayake, pointing out that in one case in the Philippines, the roads are bad and marketing is, therefore, slow and rough. There is a lot of bruising and waste that results from this marketing system. So, let us ship by rail. Dr. Senenayake says rail does not work because you have to reload and transfer too many times. It does not work in Ceylon. The road system is better in Ceylon, I believe, because of the tea industry.

I was interested in Dr. Anothai's remarks about the transportation system from Chiang Mai all the way down to the Bangkok Markets. That is a long trip, but there are reasonably good roads now and it can be done. There are some important points relative to infrastructure and institutional matters in vegetable marketing that have been touched on in these papers. Communication is an extremely important issue. I am continually amazed as I live in Taiwan to see the news broadcast on television in color showing daily vegetable prices in the Taipei market. The amazing part is not only the currency of information but the fact that it is broadcast on television, indicating that many farm families, or some market information centers such as farmers' associations have television sets.

The communication system need not be that sophisticated but there is no question that it is a key factor in solving some of the problems. Dr. Torres mentioned that in the private market in Manila, vegetables are sometimes shipped from Mindanao and back to Cebu when there is a glut in the market. You can look at this in two ways. One, the original shipper did not have good enough information. If he had known via radio or television or other communications media that there was a low price and a large supply already in Manila, he could have shipped his product directly to Cebu. But second, the private system is, in its own way, responding to price differential and demand.

There are some successful vegetable marketing specialists who are performing the function of disposing of surplus production and they make a living at it. Let us not call them middlemen. They may make a better living than the farmer in some cases, but not always. There are many small people involved in the marketing channel

Radio has become a very important tool in supplying market information. The assembly sheds or local collection points, in any country, are also an important place for the display and repetition of marketing information. I was interested in visiting a banana packing shed in southern Taiwan and the price was posted outside. A number of other commodities were listed there too. Although they were not handling most of these commodities, prices were marked so that the farmer knew what they were. This kind of communication is extremely important in serving the farmer to help him get the best from his output.

In training or education, we are trying to improve the level of capability. Professor Somporn's statistics fascinated me: 609 agriculture graduates per year in a country of 45 million people. It is frequently said that the Philippines has an oversupply of graduates and while I am not convinced it is true, I think, clearly Thailand has an undersupply of manpower. There are not enough trained people coming into agricultural information and training, into production technology, into marketing, economics,agricultural engineering, plant pathology, and all the different disciplines that are involved in vegetable production.

I hope that one of the things that will come out of our survey here is a good indication of what the status is of vegetable production, but I would like to ask a further question of how many people are needed. What is the optimum level of trained people in agriculture, and at what levels of training are they required?

The production training programs that IRRI conducted and that we have initiated at AVRDC have been extremely effective. Their programs teach practical production technology. Perhaps, we are not doing enough with marketing and with agricultural economics. It is a critical factor and we do want to increase the amount of information and the amount of up to date training that is available to the agricultural community.

We talk about the farmer controlling his marketing, but no man's judgement is any better than his information. The farmer's control of his marketing depends on his information about getting higher yields, about lowering his cost of production and taking advantage of markets, and it is our responsibility in research and training institutions to do everything we can to improve his chances of profit.

I think that brings me to my last remarks. I come back to the statement that Ruttan and Hayami made in a classic study of agricultural development in Asia. Citing Korea, Japan, Taiwan, the Philippines, and other Asian countries, they point out that, elementary education is the most important single determining factor for development in general and agricultural development in particular. We are not elementary teachers; we are agricultural researchers, and yet it is certainly true that here is where we have to start. The basic educational levels in the last analysis probably will determine how rapidly change will be brought about and how productive the development efforts that all of us make will be.

DISCUSSION

Rikken: Should we not look into consumer problems also as one of the significant constraints to the development of the vegetable industry?

Moomaw: Yes, that is important. We can include the consumer as the sixth area of concern. I am reminded of the development of IR8. We at IRRI thought we had solved the rice shortage problem when we developed IR8. But consumers preferences depend on how hungry they are.

Wang: What is the role of the government in all these areas of concern? What level of assistance should be given to the industry?

Moomaw: The government should intervene in the various operations of the industry in so far as it contributes to the efficiency of operations.

There are factors that, certainly, the private sector can not provide: road building, communication facilities, power supply, and other infrastructures that are strictly public services. Price support is another aspect the government could go into, but only so far as it does not camouflage the real supply and demand situation.

Calkins: There is no doubt that better marketing facilities and infrastructures are better provided by the government. This way the government serves as a catalyst. Regarding a price subsidy, it must be taken away after a point of stabilization has been reached; otherwise, we distort market signals. In resorting to price subsidy measures, we should study their effects on industry and the economy as a whole.

Moomaw: Sri Lanka subsidizes both the rice producer and the consumer. But you cannot subsidize both sectors without getting the money somewhere else. There is not enough income from tea and rubber exports in Sri Lanka to subsidize rice up to that level. We have to be realistic and look carefully at our resources and priorities. We cannot do everything we want to do.

Tsou: What is the major role of the survey with respect to the area of discussion you mentioned?

Moomaw: We are concerned with first, information gathering and second, problem identification. In contributing to the success of this survey, the cooperating national agencies will also draw information from the survey to improve their services for the development of the vegetable industry. Problem identification is expected to be more difficult in the social aspects of the industry.

Rikken: The survey does not need to plow into the rawest form of data. The Philippines, for instance, has already conducted an economic census on agricultural production for 1975 involving 6000 households in 10 specific regions all over the country.

Moomaw: This would substantially lighten our task. The Asian Development Bank also conducts periodic surveys in member countries but these are mostly summaries on a macro scale.

Calkins: Can you describe the forms used in the Philippine census?

Rikken: They deal with a broad range of information on agricultural production such as crops planted, main source of income, consumption, volume of market sales, extent of crop damage and estimated losses, labor absorption, etc. Of course, you could question the accuracy of recollected information but farmers are usually accurate about these things. However, the data may not be processed in the form that would be most suitable to your type of investigation.

Moomaw: Are there other countries which have or are about to conduct similar surveys?

Pandey: We have one in Nepal but it is not specific to vegetables.

Torres: You said that our main task in this workshop is to find solutions rather than problems and we will be gathering all these types of information and data. But are we really sure at this stage how we will sure of the data that we gather?

Moomaw: We feel that the task of problem identification is enough to justify this survey. We realize that you already know the problems in your own countries. And you have observed and studied them closely. But survey and statistical methods vary from one agency to another and from one country to another. We would like to assist in the collection of uniform data.

Calkins: If we can identify problems, we can also identify solutions. What we are striving to do is to gather enough significant information to be able to formulate a program for development which we could implement through the network. We are concentrating on the six items listed on the board as the target areas.

Torres: We might have different objectives in mind. Who are we really trying to help? Is it the farmer, the dealer, the producer, or the consumer? I suggest we take them one at a time. We cannot help them all at the same time. When we discuss efficiency, equity and welfare, we run into social, polictical, and economic constraints where it is easy for us to lose direction and purpose.

Rikken: On the other hand, not one aspect of the industry is mutually exclusive. We cannot deal with technology if we do not upgrade social conditions.

Castro: I suggest we divide the six areas into basic fields of study and identify bottlenecks which we could attend to initially.

Moomaw: Look at your system of data collection critically. See if it leads to solutions. Analyze the forms individually and single out solutions that can be designed in one plan. Then by some form of consensus, you could come out with new solutions. Each one draws on the knowledge and experience of the other. Then, summarize what you have discussed into a definite conclusion as to how best we can tackle these problems.

Calkins: You could rank these problems by country. By comparing country profiles, we could determine which problems commonly recur at top priority levels. Then we could consider possible solutions according to their priority patterns.

Postscript:

A PROPOSAL FOR INTEGRATED SURVEYS OF THE PRESENT AND POTENTIAL ROLE OF THE VEGETABLE INDUSTRY IN NINE ASIAN COUNTRIES

Peter H. Calkins

Participants of the Workshop on Pre- and Post-harvest Vegetable Technology agreed that the most effective way to gather useful information for vegetable development in Asia would be by conducting uniform, simultaneous surveys in their respective countries on the production, marketing, processing, and consumption of selected vegetable commodities.

First, they identified and ranked the major problems facing the vegetable industry in their countries. They assigned a score of 0 if the problem was absent, 1 if slight, 2 if moderately severe and 3 if very severe. The problems identified were then grouped into the categories, production, post-harvest, and nutrition. The results of this poll and the ranking of the problems are listed in Table 1.

It is evident that the five most severe problems are post-harvest in nature. This suggests that if only one survey can be performed it should be on marketing and post-harvest handling problems. The next general area of importance was production, with low availability of inputs and low yields regarded as the major problems. The problems ranked least severe were nutritional in nature. Lack of protein sources was considered by the participants to be a more critical problem than the lack of vitamins and minerals. This reflects the important place of grain legumes in the broad definition of vegetables adopted for use in the workshop and subsequent surveys.

Once the problems were identified, the participants decided to list the crops which could best solve them on a country-by-country basis. They chose to limit the scope of the surveys to six crops per country, to focus the results better and to establish clearly-identified target crops for later development programs. The increase in national yield and area planted to these crops will later be measured to gauge the success of the development efforts based upon the survey results.

Table 2 lists the crops chosen. Only 16 commodities are listed from the more than 100 species considered to be vegetables that could have been earmarked for development emphasis. This shows that there is already a substantial consensus on which crops should be chosen for development in Asia.

Certain crops were ranked by many countries as being very high in priority. The six crops in the region that received the highest rankings were, in descending order, tomato, cauliflower, Chinese radish, Chinese cabbage, potato, and mungbean. The participants ranked highly four of the six vegetables commodities now undergoing research at the Asian Vegetable Research and Development Center. Thus, the proposed survey can have enormous benefits both for national programs and for the breeders and other scientists at AVRDC in coordinating their development efforts.

Table 1. Ranking of the problems facing the vegetable industry[a].

Problem	Classification	Total score	Ranking (most severe =1)
Inadequate distribution system	Post-harvest	21	1 and 2
Seasonal fluctuation in vegetable supplies	Post-harvest	21	
Vegetable prices too high or too low	Post-harvest	20	3
Post harvest loss of vegetable products	Post-harvest	19.5	4
Insufficient marketing and storage facilities	Post-harvest	19	5
Low income and capital of small farmers	Production	14.75	6
Underdeveloped proceeding industry	Post-harvest	13.75	7
Low yield	Production	13.6	8
Current diet deficient in protein	Nutrition	13.3	9
Inadequate vegetable production technology at the farm level	Production	12.6	10
Limited land available for vegetable production under current crop systems	Production	11.75	
Lack of vitamins and minerals	Nutrition	11.75	11 and 12
Poor seed quality and/or unavailability for planting	Production	10.5	13
Farmers not interested in vegetable production	Production	10	14
Limited or no stimulation of the export sector for fresh and processed vegetable products	Post-harvest	8.25	15
Shortage of labor for vegetable production	Production	8	16
Insufficient promotion of vegetables through concentrated production and consumption campaigns	Production	7.25	17
Inadequate production for home consumption (e.g., home gardens)	Production	6.6	18
Few vegetables acceptable because of traditional consumption patterns	Nutrition	2.5	19
Insufficient quantities of cereal food	Nutrition	2.5	20

[a]Poll of responses from the participants at the Workshop on Pre- and Post-harvest Vegetable Technology, February 7-12, 1977.

Table 2. The ranking[a] of the six crops chosen for study in each participating country.[b]

Crop	Japan	Korea	Taiwan	Philippines	Indonesia	Thailand	Sri Lanka	Nepal	Bangladesh	Total	Top six crops
Tomato	5		6	6	5	6	6	4	5	43	6
Sweet potato			2	3					1	6	
Cauliflower								6	2	8	
Cabbage (common)	4				6	2.5	5	1	3	21.5	5
Onion	1	2		1			2	3		9	
Garlic		3				3				6	
Soybean			5							5	
Ch. radish	6	5				4		5		20	4
Lettuce	2									2	
Shallot					1	2				3	
Chili		4			3	1		2		10	
Ch. cabbage	3	6	4		2	2.5				17.5	3
Eggplant									4	4	
Wingbean				4			1			5	
White potato		1	1	2	4		3		6	17	2
Mungbean			3	5			4			12	1

[a]1 = least important; 6 = most important. [b]Workshop on Pre- and Post-Harvest Vegetable Technology, February 7 to 12, 1977.

The participants also estimated the costs in the marketing, production, consumption, and processing surveys on a country-by-country basis. This was in order to produce as accurate a plan for the surveys as possible.

Finally, the participants agreed to entrust the actual writing of the survey proposal to a team from the Asian Vegetable Research and Development Center. The following pages explain in detail the benefits, personnel, timetable, and budget for the proposed Asian Vegetable Development Survey, and embody the consensus of opinion of the Workshop participants.

BENEFITS OF THE SURVEY

The major benefits of the Asian Vegetable Research and Development Survey will derive from a systematic improvement of the information base available to national and international research organizations. By quantifying technical adequacies and inadequacies at each of six stages of vegetable technology (pre-production, production, post-harvest handling, processing, marketing, and consumption) the survey will allow individual country programs to measure technological constraints facing the development of specific vegetables.

Moreover, the consistent format will reveal whether the requisite technology to overcome these constraints is already available in another country with similar problems. For example, Japanese-developed paddy weeders are in widespread use in India, and traditional and non-traditional methods of food preservation developed in Taiwan have met enthusiastic response in Nepal. As an extension of such benefits, the proposed survey will allow members of the Asian Vegetable Research and Development Network to determine a reasonable division of labor for assigning basic and applied research projects on a country-by-country basis.

International research organizations like AVRDC will also benefit from the quantification of development priorities for vegetables in the tropics. Once major crops; genetic, physiological, and pest-induced barriers to yields; soil and management problems; and economic and dietary barriers are identified; such institutes will be able to focus their programs to better meet the requirements of the vegetable industry in the tropics.

Objectives

1. To investigate six vegetable crops per country and to share the results of the survey with the other participants and the agricultural community at large.

2. To identify, through a Producer Survey of 600 farmers per country, the present growers of the six crops in each country, their present cultural practices, insect and disease problems, levels of cost and returns, and marketing and handling procedures.

3. To measure, through a Marketing Survey of 300 agents per country, the present technology regarding post-harvest handling of the crops; levels of investment, return, and risk assumption; preferences for crops, suppliers, and buyers; and the physical and economic losses at each stage of the marketing channel (a set of metric scales is included in the equipment item of the budget, Table 3, 15).

4. To assess, through a Processor Survey of up to 20 units for each of the six crops processed, the major post-harvest and processing technologies currently being used to handle the six crops in each country, their relative efficiency and profitability, and their addition to the economic value of the crop.

5. To identify, through a Consumption Survey of 600 households, the major consumption patterns and demand response to changes in income and price for the six commodities as well as other individual vegetables and aggregate food groups.

6. To coordinate, through the meteorologic group at the International Rice Research Institute, the development of necessary background information on the agroclimatic characteristics of the present and potential areas which may grow the six crops chosen by each country. Much background information on present areas and cultural practices is currently being gathered through a standardized form.

Table 3. Estimated budget for the tropical vegetable survey.

	Bangladesh	Nepal	Sri Lanka
I. Survey Personnel			
A. Wage and per diem for 10 enumerators-coders x 78 survey days + 60 coding days	4,410	5,520	9,660
B. Per diem for 6 country coordinators x 15 survey days	540	540	0
C. Per diem for trainers & commodity team personnel (30 people x 15 survey days)	2,700	2,250	0
D. Salary for two research assistants for eighteen months	4,380	5,475	5,475
E. Per diem for two research assistants x 150 days	1,200	1,200	1,200
F. Salary of 2 statisticians for one year	2,920	3,650	3,650
G. Salary of one clerk/typist for eighteen months	1,643	2,738	1,370
H. Total cost of 4 commodity meetings for each of 6 commodities	4,800	4,800	4,800
II. Training			
A. 10 enumerators for 20 days	8,000	8,000	8,000
B. Training of 3 trainers per country by AVRDC	7,500	7,500	7,500
C. Cost of training supplies	2,500	2,500	2,500
III. Transportation and Travel			
A. 500 trips to study areas	3,500	5,000	3,600
B. Petrol or other travel cost for 1675 man-days in the field	5,863	5,863	5,863
C. Survey vehicles	4,800	4,800	4,800
IV. Paper, Printing, and Supplies			
A. Translation and printing of survey forms	5,000	5,000	5,000
B. Paper and miscellaneous supplies	3,620	3,620	5,240
V. Rent and Equipment			
A. Office space for 18 months	10,500	10,500	10,500
B. Telephone and communications	1,500	1,500	1,500
C. Standardized set of survey equipment (scales, calculators, first aid, etc.)	5,000	5,000	5,000
D. Cost of initial computer compilation of results	4,000	4,000	4,000
Subtotal (I-V)	84,106	89,456	89,658
VI. Miscellaneous & Contingency (15% of total)	12,615	13,418	13,449
Totals by country	96,721	102,874	103,107

Thailand	Indonesia	Philippines	Japan	R.O. Korea	R.O.China
17,250	20,700	12,420	25,628	10,764	20,700
450	1,480	450	603	450	603
2,250	4,500	3,015	8,100	2,250	3,375
5,475	12,154	7,337	18,287	8,850	9,090
1,200	1,200	1,200	1,200	1,200	1,200
3,650	8,104	4,890	12,190	5,400	6,060
3,669	9,375	1,095	5,475	3,669	3,669
4,800	4,800	4,800	4,800	4,800	4,800
8,000	8,000	8,000	8,000	8,000	8,000
7,500	7,500	7,500	7,500	7,500	7,500
2,500	2,500	2,500	2,500	2,500	2,500
6,250	10,000	10,000	10,000	15,000	10,000
5,863	14,070	5,863	5,863	5,863	5,863
4,800	4,800	4,800	4,800	4,800	4,800
5,000	5,000	5,000	5,000	5,000	5,000
4,430	5,240	3,620	6,860	4,430	4,430
10,500	10,500	10,500	10,500	10,500	10,500
1,500	1,500	1,500	1,500	1,500	1,500
5,000	5,000	5,000	5,000	5,000	5,000
4,000	4,000	4,000	4,000	4,000	4,000
104,087	140,423	103,490	147,806	108,963	118,590
15,613	21,063	15,524	22,171	16,344	17,789
119,700	161,486	110,014	169,977	125,307	136,379

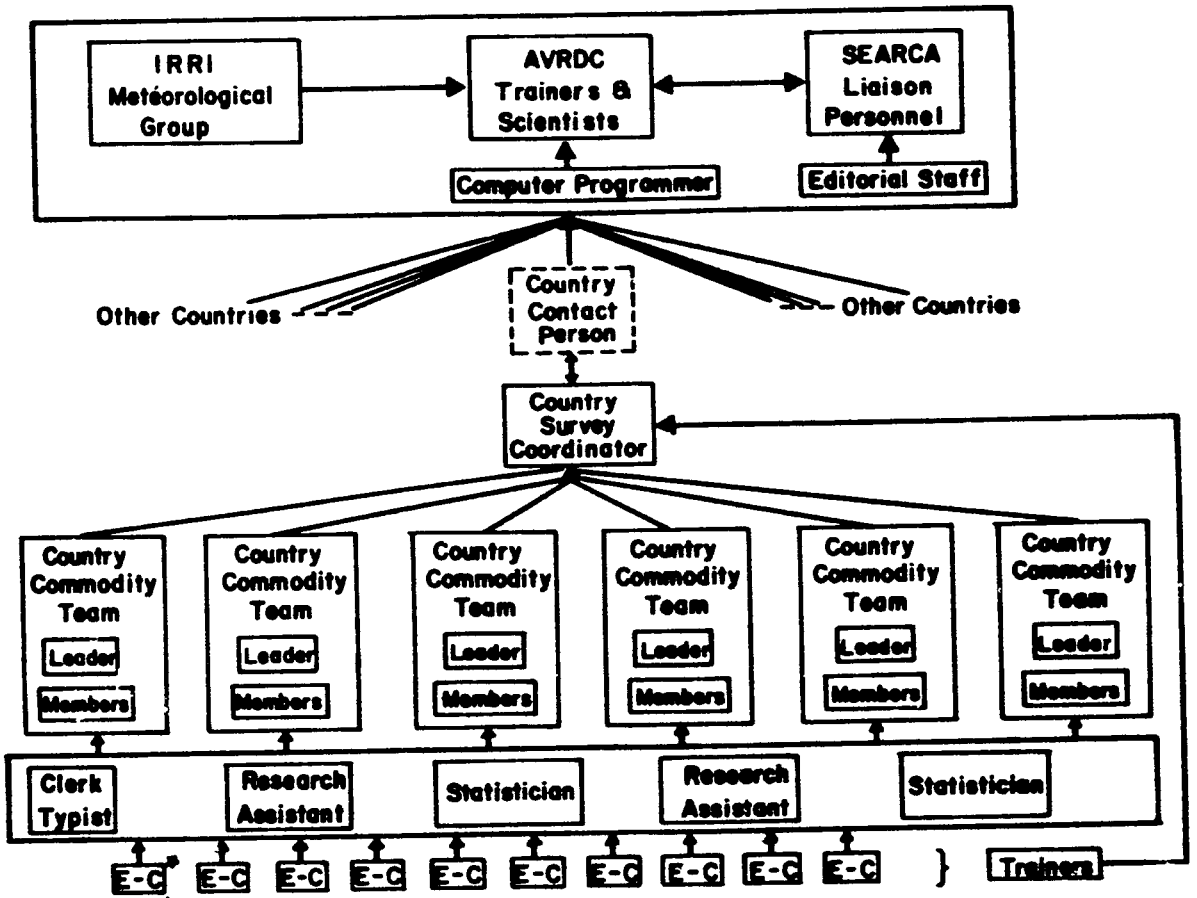
Table 3. Estimated budget for the tropical vegetable survey. (Cont'd)

VII. International Coordination	International Institutes
A. Newsletter (AVRDC)	3,500
B. Cost of developing agroclimatic range maps (IRRI)	20,000
C. Central computer analysis	50,000
D. Salary of computer programmer (including travel & initial consultancy fee)	30,000
E. Printing of final results in book form	10,000
F. International travel for AVRDC scientists	50,000
G. International travel for SEARCA staff	15,000
H. Overseas travel for country coordinators (2 short trips x persons)	108,000
Subtotal (VII)	286,500
Subtotal (I-VI)	1,134,565
Grand total	1,421,065
Total with two additional countries	1,664,335

PERSONNEL OF THE SURVEY

Figure 1 shows how the personnel of the survey will relate to each other in terms of responsibility and function.

Fig. 1 Division of responsibility and function for the Asian vegetable survey.



*E-C = Enumerator coder

At present, there is a temporary country contact person who is acting to coordinate correspondence and other preparations until the survey is approved. (Their names bear two stars in the foreword of this volume.) Upon approval of the proposal, a country survey coordinator will be chosen to replace the country contact person and to assume the major responsibilities of making the arrangements for the training, conducting, and analysis of the survey over the entire 18-month period.

The country survey coordinator will be in charge of six country commodity teams, one for each of the six commodities chosen for study in each country. There will be six to eight members on each country commodity team, who will represent a wide range of scientific disciplines and, it is anticipated, several different national institutions, where they will continue to work nearly full-time. Such persons will be called country commodity team members. One of these will have the responsibility of directing the research on a given commodity in the country and will be termed a country commodity team leader. The six country commodity team leaders will be responsible to the country survey coordinator.

The actual surveys will consist of interviews of a total of 1620 respondents. These interviews will be performed by a team of 10 enumerator-coders for each survey. The enumerator-coders may or may not be the same for each of the surveys, depending upon the availability of college students, junior staff members, and other potential candidates in a given country. The selection of the enumerator-coders will be made by the country survey coordinator, with advice from the country commodity team leaders and the trainers.

There will be three trainers from each country who will represent a range of disciplines including the agricultural sciences, economics, and education. They themselves will be trained by AVRDC personnel in the objectives and methods for conducting each survey, and will then train the enumerator-coders for each survey just before the time it will begin.

During and following the survey, two research assistants, most probably agricultural economists, will be in charge of the enumerator-coders in the field and when they are checking the survey results. They will also be responsible for preliminary writing of the research results and other background information on each commodity in each country. Their main task will be to ensure that the data are accurately taken and that the results are meaningfully integrated with previous and ongoing work in agricultural development in the country.

After the surveys are checked, the enumerator-coders will be under the supervision of the statisticians, who will instruct them on the coding of the survey results. The statisticians will also be in charge of readying the results for computer analysis and arranging for cards to be punched. In the event that standard IBM tape punching facilities are not available in a country, the data sheets can be sent to the central computer facility for the survey. This will probably be at the Asian Institute of Technology in Bangkok or the newly-creasted computer facility in Los Baños.

Before the questionnaires are distributed to each country for translation, they will have been prepared for coding on a consultancy basis by the computer programmer. He will then be hired for a year-long period extending from month 7 through month 18 of the survey period to determine, perform, and integrate a wide range of statistical and equational analyses of the data sheets as they arrive from each country. He will be stationed

at the site of the central computer facility and will send back a copy of each country's results to the research assistants, who, with the help of the statisticians, will write preliminary chapters on the survey results.

Each country will also have a clerk-typist to assist with correspondence and the initial analysis the results.

To integrate, supervise, and improve the technical quality of the surveys, country commodity meetings will be held for all involved in the surveys in each country, and provision will be made for travel to the field by country survey coordinators, team members, and trainers. Moreover, travel to international meetings and other travel will be provided for, so that country survey coordinators, AVRDC technical experts, and SEARCA liaison personnel can monitor the progress of the surveys and correct problems as they arise. A newsletter, published at AVRDC, and the strengthening of research libraries in the participating institutions are also recommended.

Time Table for the Survey

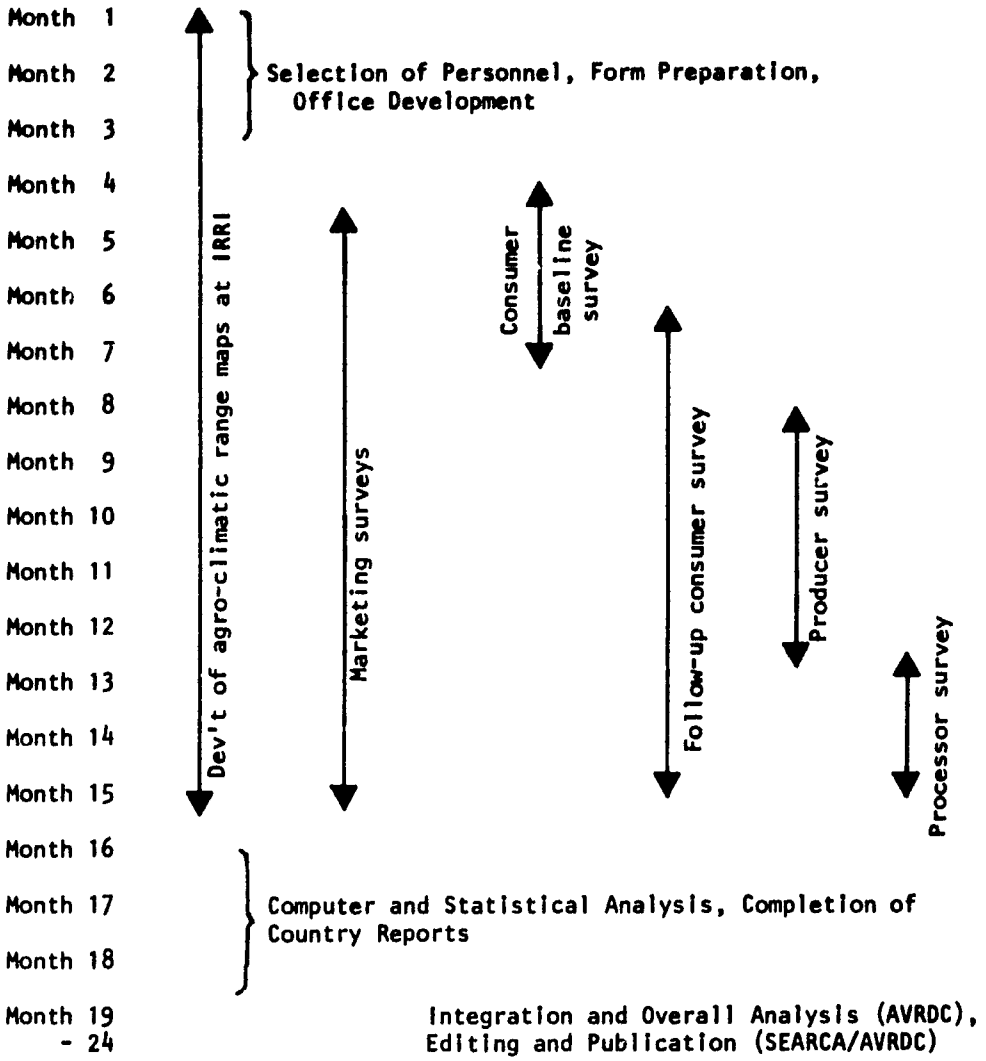
Figure 2 shows how the six objectives of the survey will be met over a 24-month period from the inception of the project.

The first three months will be devoted to the selection and orientation of personnel, the coding of survey forms by the computer programmer, the translation of the forms into the local language in each country, the provision of office space and arrangement for typewriters and other equipment, and the beginning of agroclimatic range map development at IRRI for the crops chosen by all countries. Such climatic maps will not be finished before the inception of the surveys, but every effort will be made to finish them early in the survey period.

The consumer survey will be conducted in 20 days in the fourth or fifth month and coded in 15 days in the fifth or sixth month (depending upon the urgency of the marketing surveys for crops harvested in that period). From the original sample of 600 chosen to represent consumers of varying income groups from four urban centers of various sizes, a subsample of 200 will be chosen (on the basis of their willingness to cooperate), to participate in a follow-up "shopping-list." This survey will measure over a nine-month period the seasonal patterns in buying behavior and price response. The enumerator-coders and/or research assistants will collect such lists on a biweekly basis.

An exclusively urban sample population for the consumer survey will be chosen because (1) rural consumption patterns of vegetables can be partially assessed from marketed percentages in the producer survey, (2) the major impact of reductions in price through improved marketing will be felt at increasing distance from producing areas, (3) the differences in income in urban areas are frequently greater than in rural areas, and (4) with the limited number of observations feasible under even a larger survey, it seems preferable to sample a high proportion of a clearly identified urban consumer population.

The marketing survey will be conducted for the six crops at the time they are marketed. Total time, distributed over a twelve-month period from month 4 through month 15, will be 15 days for interviewing, and 8 days for coding.



Division of Enumerator-coder mandays:	Survey work	Coding work
Consumer Survey		
a. Baseline	200	150
b. Follow-up	80	100
Marketing Survey	150	80
Producer Survey	200	150
Processor Survey	60	60

Fig. 2. Tentative time table for the Asian vegetable survey.

The producer survey will be conducted for 20 days in month 8 or 9 and coded for 15 days in moth 10 or 11. Three major production areas for each crop will be chosen by the country commodity team on the basis of their potential increase in yield or potential for planting should improved technology be developed.

The processor survey will be conducted for 6 days in month 12 or 13 and code for 6 days in month 14 or 15. The major purpose of the processor survey will be to identify the relative profitability and efficiency of various processing technologies.

Months 16 through 18 of the survey will be devoted to computer and statistical analysis of the results and completion of the preliminary draft of country reports. These reports, as well as the entire set of results from the central computer analysis, will be sent to AVRDC for integration and the addition of summary chapters and interpretive data.

Months 19 to 24 will be devoted to writing up the results. The manuscript will be sent to SEARCA for editing. Printing of the final results will be done at AVRDC. Thus, the formal survey structure will be necessary for only 18 months. Editing and printing will be conducted using survey funds at existing facilities.

Budget for the Survey

The budget for the survey is detailed in Table 3. It is presented by item-as well as by country, so that funding agencies may choose those parts they wish. In the event that an agency wishes to fund an individual survey in one or more countries, a computation of the percentage of total survey expenditures may be made on the basis of the survey and coding days listed at the bottom of Figure 2. The ranking of the importance of the individual surveys is, in decreasing order: marketing, production, consumer, processor.

In addition to the nine countries already agreeing to the present proposal, provision is made at the end of the proposed budget for two additional countries. Malaysia has already indicated a willingness to participate in the survey. India is another prime candidate for inclusion.

APPENDIX

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156