Postharvest Institute for Perishables

# An Integrated Approach to the Study of Postharvest Problems In Tropical Countries:

## A Case Study in Taiwan

by
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Asian Vegetable Research and Development Center

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Mr. Jerry La Gra
Dr. James R. Jones
Dr. Samson C. S. Tsou
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# PART ONE

## An Integrated Approach to the Study of Postharvest Problems in Tropical Countries

### A. INTRODUCTION

Postharvest losses of perishable products are generally considered to be excessive in the developing world. Little systematic research has been done to determine the cause and magnitude of these losses and their relative importance at distinct points along the marketing channel.

The Asian Vegetable Research and Development Center (AVRDC) is interested in extending its activities in production to include control of postharvest food losses. For this purpose, the AVRDC and the Postharvest Institute for Perishables (PIP) are considering initiating a joint activity to identify the basic elements to include in a potential regional program to provide technical cooperation in the control of postharvest food losses.

Dr. J. Jones, from the University of Idaho, and Mr. J. La Gra, from the Inter-American Institute for Cooperation on Agriculture, went to AVRDC for the period September 10 to 30, 1983, to do some fundamental studies that would provide a basis for future collaborative efforts. While at AVRDC they worked with Dr. S.C.S. Tsou of that institution.

The following objectives were assigned to Jones and La Gra while working at AVRDC in Taiwan:

1. Develop a methodological base for doing case studies in Indonesia, Thailand, and the Philippines. This methodology will consist of a detailed scope of work for identifying and addressing country problems to determine magnitude, priorities, and specific needs of country loss control programs.
2. Apply the case study methodology to Taiwan.
3. Prepare a final report including the methodological approach suggested and the modifications introduced by its application in Taiwan.
4. Identify possible areas for future collaboration between PIP and AVRDC.

## B. FRAME OF REFERENCE

During the past decade considerable attention has been given to the "extremely high" levels of postharvest food losses. International organizations and institutions have encouraged activities oriented towards the quantification of the losses, the design and transfer of improved technologies, and an improved flow of information and technical assistance to the developing world.

Whereas some progress has been made in quantifying and designing projects to control cereal grain losses, relatively little has been done other than reviews of literature, international seminars, and short-term consultancies in the area of losses of perishable foods.

Experts in the field of postharvest handling of perishables point out that:

1. Considerable scientific literature exists on the micro aspects of insect, disease, and storage problems of many perishable commodities.
2. Postharvest losses of perishables may vary from near zero to 100% depending on a variety of factors including: the definition given to losses, country, preharvest conditions, disease, insects, rodents, geographic location, climatic conditions, length of storage, harvest techniques, type of packaging and transport, cultural influences, consumer demand, and an almost unlimited list of others.
3. In general there has been a difference between the technologist's view of the postharvest system and the agricultural economist's view of the marketing system.
4. It is still unclear what a postharvest food loss is and what types of losses are priorities.
5. While cereal grains include only a few products of importance, perishables include three major groups of importance, i.e. fruits, vegetables, roots and tubers.

Consequantly, the feasibility and value of a detailed quantification of postharvest losses on a country basis is questionable until a more general qualitative diagnosis of losses is done.

Prior to implementating studies to quantify losses, researchers must establish:

1. Whether country officials and specialists consider postharvest losses a problem or not and, if so, what institutions are involved.
2. What actions are being taken.
3. What commodities are considered priorities to the national economy.
4. Where losses occur and what are the causes.
5. Where limited resources should be allocated?

Decisions made on an a priori basis, particularly at the international level, can lead to a misallocation of scarce national resources. Therefore, it is important to do a systematic diagnosis of the postharvest system on a country basis as a first step in any country program of resource allocation.

Most developing countries have an institutional structure including planning offices, ministry of agriculture, marketing institute, research/technological institutes, universities, training centers, and agricultural banks. These institutions normally function independently and although each might have some common activities, e.g. planning, research, training, food handling, financing, or food conservation, it is likely that they are done on an individual, and often ad hoc, basis with little consideration for the overall food system.

While regional and international resources oriented towards the identification and reducton of losses are considerable, they are consistently under-utilized at the country level. Moreover, they often broaden the inter-institutional gap by favoring one national institution over another rather than stimulating the development of a systematic, national postharvest food program.

Two international institutions interested in improving the conservation of perishable produce in the developing world are the Asian Vegetable Research and Development Center (AVRDC), in Tainan, Taiwan and the Postharvest Institute for Perishables (PIP), at the University of Idaho. The former has concentrated its efforts on plant breeding to increase yields and improve disease, pest, and climatic (heat and flooding) resistance, all of which are preharvest factors which may significantly affect postharvest life of agricultural crops. PIP has concentrated on establishing a postharvest

information network for perishables and providing short-term technical assistance to country projects. At present, PIP is developing a capability for postharvest loss assessments of perishable crops at local, sectoral and national levels. Both institutions agree that integrating their resources would create a much greater impact at the country level.

It is proposed that AVRDC and PIP develop a three-stage strategy oriented to integrating their resources in an attempt to strengthen institutional and private sector capacities to deal with postharvest problems at the national level. It is further proposed that the strategy be implemented in the near future in Thailand, Indonesia, and the Philippines in conjunction with AVRDC outreach programs.

The three stages of this proposed strategy are the following:

Stage I. Country Diagnosis

This diagnosis includes two steps: first, the design of a methodological approach to execute the postharvest diagnosis at the country level and, second, visits to at least three developing countries to undertake the diagnosis.

(The second and third stages depend upon the results of the first stage, however, the following content can be suggested a priori).

Stage II. Development of Human Resources

Preliminary diagnosis in many countries shows that while a broad institutional base exists to implement postharvest loss reduction activities in research, training, transfer, planning, food handling, and others, the human resources to execute such activities are scarce or nonexistent. Thus, the second stage of an AVRDC/PIP strategy is to upgrade the level of human resources through systematic and organized national and international training programs.

Stage III. Support for the Execution of National Programs to Improve Food Supply Systems

The end result of AVRDC/PIP actions in postharvest must be felt at the national level through increased supplies of better

quality food at the consumer level. This result can best be obtained by continuous support of national institutions and private sector organizations which form part of a systematic national effort to improve the efficiency of the overall food system. The human resources formed during Stage II, using information obtained during the diagnosis in Stage I, should participate actively in the implemention of the PIP/AVRDC support activities.

Because agricultural production and marketing systems and public sector institutions in Taiwan are more highly developed than are similar systems and institutions in developing third world countries, Taiwan is an ideal country to use as a model.

## C. SUGGESTED METHODOLOGY FOR COUNTRY DIAGNOSIS*

The methodology outlined below focuses investigations on a country basis so as to generate the information necessary to answer the following questions:

1. Are postharvest losses a problem?
   If so,
2. What are the priority products?
3. What are the principal causes of the losses?
4. Is loss reduction given priority by planning authorities?
5. What institutional activities are underway to control losses?
6. What technical personnel are involved in research, training, transfer, planning, food handling, or other activities related to postharvest?
7. Do they consider postharvest losses to be important?
8. Have loss assessments been made?
9. What literature exists on the subject?
10. What alternative sources exist for financing loss reduction activities?

The information comes from two distinct sources: public sector institutions and representatives of the private sector marketing system.

### Institutional Diagnosis

The institutional diagnosis is brief and to the point, and includes all institutions important to the agricultural sector which have postharvest activities. At least one institution is studied for each of the following areas:

1. Planning
2. Research/investigation
3. Teaching/training
4. Transfer/extension
5. Marketing.

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*Based upon 8 years of experiences of IICA in the Caribbean and Central America.

Interviews with representatives of each institution are held with two types of persons:

1. those who have an thorough understanding of the institution itself and
2. those who work directly in postharvest activities.

The information collected from each institution includes, at the minimum, the following:

1. Name, address, telephone, acronymn
2. General and specific objectives of the institution
3. Products, in order of importance
4. Description of functions and organizational structure, identifying departments, divisions, and sections or units concerned specifically with postharvest problems.

Information collected from each institutional unit having postharvest activities should include the following:

1. Type of activity (research, training, planning, transfer, storage, packaging, wholesaling, or other)
2. Priorities in terms of products, type of training/research, information transferred
3. Description of activities
4. Objectives, goals
5. Intended beneficiaries
6. Source of funding
7. Results obtained
8. Key personnel (name, title, address and telephone number)

This information can be obtained with one or two visits (interviews) to each institution. It can be supplemented with available printed material, such as planning documents, annual reports, public relations literature, loan documents, studies, and miscellaneous other documentation which describe objectives and functions of the institution.

Marketing Channel Diagnosis

Technologists tend to be specific in their studies of postharvest problems and the economists tend to generalize in their institutional studies where they emphasize planning, models, information and infrastructure. The methodological approach suggested here attempts to integrate the two disciplines so as to provide a descriptive analysis of the whole food marketing system for a particular product.

Economists and marketing specialists usually present graphics of marketing channels followed by specific commodities between producer and consumer. This technique is valuable for identifying the principal types of intermediaries or participants in the marketing process and for showing their relative importance in percentage terms. However, it is of limited value in identifying weaknesses or constraints in the market system where losses may occur. It is thus necessary to use a more detailed approach using a flow diagram which identifies each participant and each action which affects the commodity as it moves towards the final consumer.

Because participants in the food system are aware of losses and have a feeling for whether they are significant or not, a series of interviews with knowledgeable participants at key points in the marketing system provides valuable information on the magnitude of losses, their causes, and the feasibility of loss reduction. With this information, in many instances it may not be necessary to enter into any further analysis of food losses. If more data, are required it is relatively easy to design a study to quantify losses. The methodology for collecting this information is simple and straight forward, consisting of field visits and interviews with some of the following: farmers, farmer organization leaders, laborers, middlemen, wholesalers, truckers, retailers, warehouse and cold storage operators, processors, exporters, and consumers. The instrument, as used in Part Two - A Case Study in Taiwan, for summarizing the information is in table form with "points in the marketing system" identified at the top along the horizontal axis and a list of six questions in the left margin along the vertical axis. The six questions are:

1. Who is responsible for the activity?
2. What action is taken?
3. How is action taken?
4. When is action taken?
5. Why is action taken?
6. Where is action taken?

Answering each of these questions for each point in the marketing system where the product is harvested, assembled, packaged, transported, delayed, stored, processed, unloaded, exported or sold provides information to facilitate determining the significance of losses, their causes, and the possibilities for loss reduction in economic terms.

Outline for Country Diagnosis

Once the institutional and the marketing channel diagnoses are complete, the results can be combined with information from secondary sources to prepare the country evaluation, which will define problems, needs, and AVRDC/PIP actions to assist institutions to overcome their postharvest problems.

As presented here, the country evaluations are divided into six sections.

1. MACRO COUNTRY DATA

| Content | Purpose is to determine: |
|---|---|
| a) Geography | a) Land area and distribution |
| b) Demography | b) Population distribution |
| c) Economy | c) Income levels, labor use, development potential |
| d) Agricultural sector | d) Priorities, resources, production potential |
| e) Commerce | e) Imports, exports |
| f) Literature | f) Principal postharvest publications |

This information is readily available from secondary sources and can be summarized in no more than two pages.

## 2. ECONOMIC AND AGRICULTURAL DEVELOPMENT POLICY

| Content | Purpose is to determine: |
|---|---|
| a) Priority sectors | a) Relative importance of agricultural and food processing sectors vis-a-vis others |
| b) Agricultural sector policy | b) Trends of agricultural policy and priority subsectors |
| c) Impact of agricultural policy | c) Effectiveness of sector policies |
| d) Policies affecting post harvest activities | d) Importance given to postharvest activities |

This information is normally available in planning office documents. It can be summarized in one or two pages.

## 3. INSTITUTIONAL DIAGNOSIS

| Content | Purpose is to determine: |
|---|---|
| a) Name/address/telephone | a) Identification of institutions |
| b) Objectives | b) Overall orientation or direction of institution |
| c) Products of interest | c) Priorities of institution compared with other institutions and country priorities |
| d) Functions and organization | d) Specific postharvest functions, responsible units and personnel |
| e) Detailed information on departments with postharvest activities | e) More specific objectives, goals and methods of operation |
| f) Details on each postharvest activity | f) Relative importance of research, training, transfer; results and personnel |

This information is obtained from interviews with representatives of the respective institutions and can be summarized succinctly in from two to six pages for each institution, depending on the number of activities in the postharvest area.

## 4. PRODUCT MARKETING CHANNEL DIAGNOSIS

| Content | Purpose is to determine: |
|---|---|
| a) Product information: volume and value, employment, nutritive value, others | a) Importance of product to national economy |
| b) Principal problems in handling product from institutional viewpoint (infrastructure, personnel, durability, or others) | b) The institution's response to the major problems |
| c) Marketing channels | c) Channels and subchannels and their relative importance |
| d) Participants and functions | d) Who does what and how and when and why and where? |
| e) Principal problems and causes | e) Problems and their causes |
| f) Alternative solutions | f) Feasible solutions to the problems identified. |

The information for item (a) can be obtained from secondary literature. The information for item (b) is generated during interviews at each institution. The remaining information (c), (d), (e), and (f) results from field trips, interviews with participants and observations. This section is the most important of the diagnosis and is as detailed as possible, particularly points (c) to (f).

## 5. ELEMENTS OF A NATIONAL STRATEGY TO CONTROL POSTHARVEST FOOD LOSSES

In some countries it may be desirable to prepare a specific national program or project, with the participation of various existing institutions oriented towards the control of food losses. In most countries, however, it is more likely that government officials prefer to broaden the functions of

existing institutions or to assign them additional responsibilities and/or additional resources. Whichever is the case, the individual postharvest activities, with their respective institutions and resources, can be considered elements of a national strategy to improve the overall food supply system. For these elements to be turned into an effective, integrated strategy, however, each institution must understand its respective role and must have the human capability and financial resources to accomplish it.

In this section, the elements of a national strategy, the responsible institutions, and the required resources are identified.

| Content | Purpose is to determine: |
|---|---|
| a) Problems to be solved | a) Problems by priority |
| b) Postharvest activities to include in strategy | b) Priority of activities in solution of problems |
| c) Institutional responsibility | c) Role of each institution in accomplishing the postharvest strategy |
| d) Resource requirements | d) Cost of completing the distinct activities. |

This information will result from the analysis of information compiled in the previous four sections.

## 6. AVRDC/PIP SUPPORT ACTIVITIES

It is necessary to identify and describe alternative support activities in which AVRDC, PIP, or both may participate. The purpose of the AVRDC/PIP activities will be to strengthen those actions implemented by the individual countries as part of their national postharvest or food supply improvement strategy. These activities normally fall within one of the following four categories: information, training, research, and/or technical assistance.

## D. CONCLUSIONS AND RECOMMENDATIONS

The conclusions of this interdisciplinary team are grouped into four categories: 1) postharvest losses, 2) the need for improved methodology, 3) the importance of integrating postharvest activities into national development programs, and 4) results of the case study in Taiwan. The conclusions are followed by a summary of recommendations for future PIP/AVRDC actions. Although time for this project has been short, the previous experiences and knowledge of the team members have facilitated a free interchange of ideas and, consequently, a much broader analysis than originally expected.

### CONCLUSIONS

1. Postharvest Losses

   a. Postharvest Losses in Chinese Cabbage

      Four distinct types of losses are found:

      1) Shrinkage losses caused by high temperatures. This type of loss is very high during the summer months. Refrigeration technology exists to minimize this type of loss but may be uneconomical to apply.

      2) Removal of outer leaves. The farmer does not remove the outer leaves which protect the vegetable during the marketing process. The removal of these leaves at the wholesale or retail market prior to sale, results in a weight decrease from between 20 and 40 percent of the original weight. The outside leaves, which are often used for animal feed, should not be considered losses. Without this protection the vegetable would require packaging materials and thus increase the farmer's expenditures. The net loss at this point should be the difference between the value of added packaging necessary if leaves were removed at the farm and the value (weight times average price) of the leaves which improved packaging would save. Participants tend to think that additional packaging costs would exceed the value of produce saved.

3) Quality losses. As the vegetable moves through the marketing system, it may be bruised or injured due to inadequate packaging, rough handling, delays, poor transport or various other causes. All of these factors may affect product quality, and result in a low grade, and consequently, a reduction in returns for the seller. This type of loss can be diminished by improved handling; however, the economic feasibility varies with each individual case.

4) Production planning losses. Substantial product losses often occur due to faulty planning of agricultural production. Since most production is derived from small farms it is difficult to equate supply with demand. Favorable production characteristics lead to excessive supplies and lower prices, and permit consumers to be very selective in their purchasing. Selective purchasing results in increased spoilage and losses at both retail and wholesale levels.

b. Postharvest Losses in Salad Tomatoes

The only losses in tomatoes are quantity losses, due to substandard quality, which occur during harvest, during the edge-of-the-field pre-packing process, and, to a much lesser degree, at the packing shed operation. Losses during harvest most often result from overripeness, disease, insects, and severe cracking caused by the weather. Affected fruit are normally left in the field and are a total loss. This type of loss can be reduced by better disease and pest control and more frequent harvesting. However, in many cases the added expense offsets any potential economic benefit. Since added costs are known, but potential returns are only speculative, the conservative farmer is normally unwilling to take the added risk.

Losses which occur during the pre-packing stage at the edge of the field are low, at least in times of product scarcity, and are most often tomatoes with disease, insect or severe cracking problems overlooked during harvest.

The tomatoes which are rejected at the packing shed operation are normally below market standards in terms of size, color, ripeness, and shape or degree of cracking. These are separated but are not discarded. Some are sold at the lowest possible grade; others are sold to restaurants for frying (appearance is not important) and the remainder are thrown to the ducks. At this point losses are minimal if they exist at all.

c. Seasonal Loss Variation

There is a large difference in postharvest losses between summer and winter months. Summer is characterized by short supply and low quality, due to heat. The consumer is forced to pay a higher price for lower quality produce. Losses due to shrinkage are higher while quantity losses are lower. When monsoons hit the vegetable producing areas, preharvest losses can reach 100%; produce that does enter the market channel deteriorates rapidly and prices at wholesale and retail markets soar. Winter, on the contrary, is characterized by very large supplies, better weather conditions, and correspondingly low prices. Losses due to shrinkage are reduced as a result of lower temperature. However, quantity losses are higher as the farmers, wholesalers, and retailers discard produce to meet the high quality demands of the consumer.

d. Alternatives for Reducing Losses

Like most fresh vegetables in Taiwan, Chinese cabbage and tomatoes reach the retailer, and often the consumer, within 24 hours after harvest. Therefore, alternatives for reducing losses appear to be limited to improved handling and packaging at the rural level. Transportation facilities appear to be adequate and storage is very short term (a few hours). Processing, although technologically possible, is not a realistic alternative, due to the consumers' preference for fresh produce and the potential for year-round production. However, as urban populations grow and incomes rise, processing may become a viable alternative. In industry, of course, processed products are well received and undoubtedly serve as a partial substitute in times of salad tomato scarcity.

e. Loss Figures from the Literature

References (2, 3, 17) are found in the literature on postharvest losses of vegetables in Taiwan. A study in 1966 showed losses for vegetables, in general, of 3.11% at the wholesale level, 4.08% at the retail level, and 7.19% total loss, which represented 6.36% of the retail value (17). The same author for the 1967-68 crop year found losses in Chinese cabbage during the winter season to be 20.0% at the wholesale level, 9.2% at the retail, and 29.2% total loss which represented 16.45% of the retail value. During the summer season the loss at wholesale was cut by 50% to 10%, retail loss remained at 9.2%, and total loss was 19.2% which represented 10.28% of retail value.

Another study (2) in 1981 showed Chinese cabbage losses at 2% between farm and shipper, 20% between shipper and wholesaler, and 4% between wholesaler and retailer for a total loss of 26% for a shipment between central Taiwan and Taipei city.

A third study (3) reported results from 1978, with total physical losses (including shrinkage) of 32% in Chinese cabbage and of 32% and of 12.4% in tomatoes.

f. General Conclusion about Losses

Because postharvest losses in perishables can be caused by many variable factors, precise quantification is extremely costly. A rapid, low investment methodology is more useful in evaluating postharvest losses and causes in fruits and vegetables, at least in the early stages of investigation.

2. Need for Improving Postharvest Research Methodology

a. Value of Existing Methods

While any research which produces new information is valuable, the results of the research may be misleading or the research itself may be incomplete. When researchers emphasize micro data (loss figures), they may overlook the causal factors of the losses. If losses are reported at "24.6%," it is important to know if the harvest, assembly, transport, packaging, wholesale, retail and related functions were done under normal conditions or if one of the

hundreds of possible influencing factors affected the loss in a signficant manner. Determination of whether the losses can be reduced in economic terms is more important than precise loss quantification.

b. Technology Versus Economics

The study of postharvest losses lacked an interdisciplinary approach. As a result, technologists have concentrated on details without adequate evaluations of the economic incentives for introducing improved or new technologies. The economists, if concerned at all, have paid more attention to an overview of the marketing system and have concentrated on marketing channels, margins, costs and price information and not an obvious need to introduce more economic analysis into postharvest loss analyses. Since the willingness of the consumer to finance food services is the key to determining when new technology can be introduced into the food system, the economist can develop models to facilitate this type of decision.

c. Towards an Economic "Model" for Measuring Postharvest Losses

According to the Committee on Postharvest Food Losses in Developing Countries in its Report for the National Research Council and National Academy of Sciences, "postharvest losses of major food commodities in developing countries are enormous, in the range, conservatively, of tens of millions of tons per year and valued at billions of dollars" (34). The report also states that "any effort to reduce food losses must begin with a quantitative assessment of the problem. However, loss estimates...are location and season specific to a degree that makes the concept of loss almost meaningless." This statement summarizes the experience of researchers as well as that of postharvest planners. Postharvest loss is significant, but the measurement of losses evades analysts and researchers.

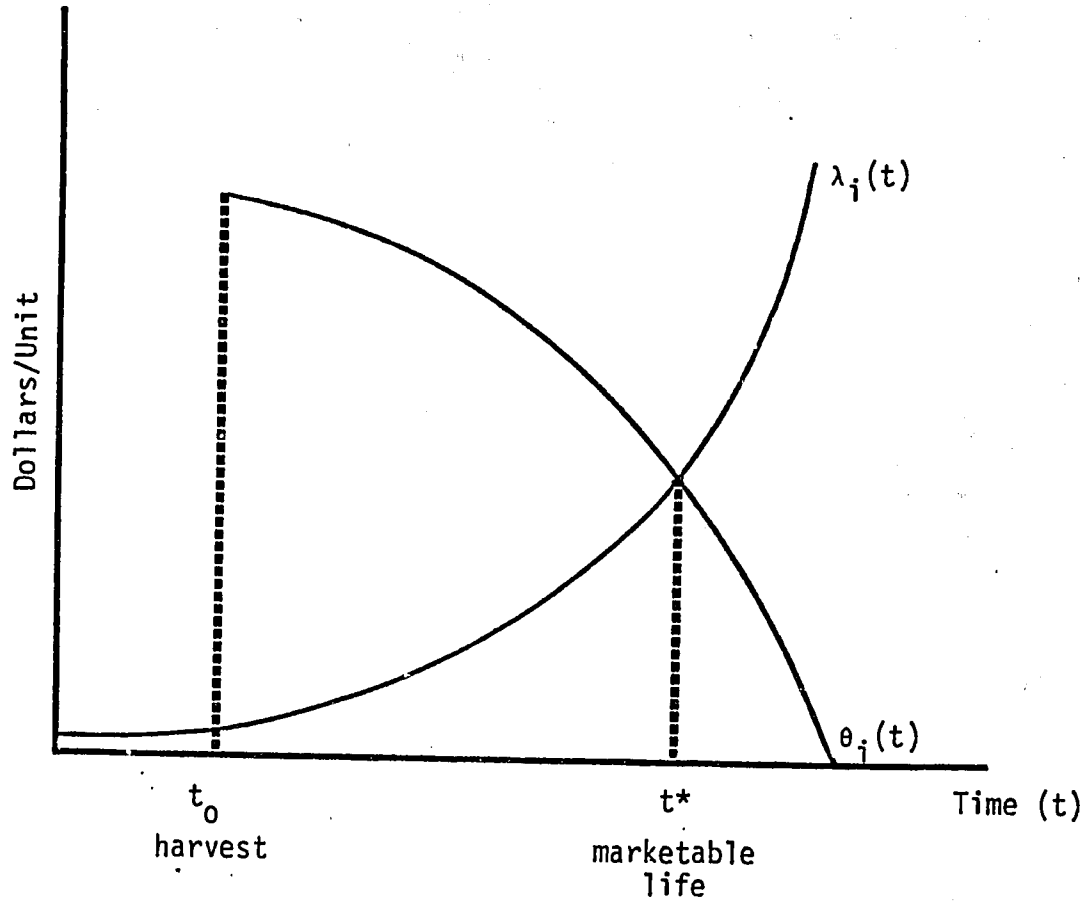
A problem in evaluating or measuring postharvest loss is how individual processes or activities designed to reduce losses, e.g. handling, storage, and packaging, should be analyzed in economic terms. A starting point could be to identify an expected shelf life of the product in the phase of marketing under question and assign a deterioration charge much in the same manner that depreciation is charged to a capital asset. The objective is to measure loss during a given period of time associated with the particular marketing activity - whether it be assembling, handling, processing, packaging, storage, transporting or other. The depreciation of the value of the product reflects the share of its total value that has expired during the marketing period. In other words, the appropriate measure of loss (deterioration) is the amount by which the shelf life of the product is consumed or reduced as a result of the particular marketing activity or group of joint activities. Similarly, the net balance in the value of the product at any point in time reflects the unexpired portion of its value.

Expressing the loss associated with a marketing activity in value terms provides information that can be used as a basis for action to reduce or minimize the rate of loss, or, in other words, to increase the economic life of the perishable commodity. Defining depreciation, i.e. reduced shelf life, must include physiological deterioration as well as costs of handling, packaging, and storage methods associated with extending or preserving shelf life. At some point these increase preservation costs exponentially as the shelf life of the commodity is extended longer.

Figure 1 demonstrates how the shelf life of a perishable commodity may be expressed in economic terms. Dollars per unit are measured on the vertical axis and time is measured in some suitable unit, such as hours, days, weeks, or months, on the horizontal axis.

A product loss function (t) measures the value of a perishable commodity through time. The mathematical form of this function is determined by the rate of physical deterioration and price associated with the commodity. The rate of determination is a function of the physiological characteristics of that commodity and the actual methods of handling the commodity. The location and shape of this function is also based on the price of the commodity. The latter is a function of demand and supply conditions in the market. The function (t) is a cost preservation function associated with preserving the shelf life of the commodity and is, therefore, upward sloping to the right. The mathematical form of this function is determined by available technologies and their respective costs. This framework allows the researcher to define the economic shelf life or marketable life of the commodity as the point in time associated with the crossing of these two curves. The economic shelf life of the perishable product is maximized in that the cost of extending its life beyond that point by tne designated technique is greater than the value of the product.

This theoretical framework gives economic meaning to assessing the practicality of reducing physical postharvest losses. Whether a change in technique (i) has economic value in extending the shelf life of a perishable depends on whether it shifts $_1$(t) further to the right than $_i$(t). Although a more definitive development of the approach is needed, discussions on postharvest technology are more meaningful if the costs of their application are included along with estimates of their effect on conserving or extending the shelf life of a commodity.




$\theta_i(t)$ = Product loss function

$\lambda_i(t)$ = Preservation cost function

i = a given technology or combination of processes for marketing the commodity in question

Figure 1. Marketable Life of a Perishable Commodity

A theoretical application is as follows. In Figure 2, $_1(t)$ represents the product loss function for tomatoes when the product is carried to market in a bamboo basket and when the only physical storage facilities are sheds used for shade. The function $_1(t)$ is the associated cost of handling and preserving tomatoes by this technique. If cardboard boxes and refrigerated storage techniques are introduced the new product loss function $_2(t)$ shifts up and to the right and thus reflects a longer shelf life and higher value of tomatoes as quality is maintained for a longer period of time. However, whether the marketable life of tomatoes has been increased depends upon the cost of introducing the new technique and the increase in value of the product. For example, if the cost function only shifts to $_2(t)'$, the economic life of tomatoes is extended, but if it shifts to $_2(t)''$, the original technique extends the economic shelf life of the perishable longer. Technical improvements that result in less deterioration of a commodity are not always accepted.

Application of the theory shown above will explain why a technique may be economically viable in one society and not in another. In a relatively high income society, the price premium that consumers are willing and able to pay for higher quality tomatoes might mean that $_1(t)$ shifts up much more in proportion to $_1(t)$ than it would in a low income society. In other words, (Figure 3), introducing the new postharvest technique in the high income society may shift the product loss function to $_2(t)'$, but it may shift only to $_2(t)''$ in the low income society because consumers are unable or unwilling to pay a high premium for the improved quality of tomatoes. If the same cost function $_2(t)'$ is assumed in both societies, economic shelf life increases by this technique in the high income society, but not in the low income society.

Because these economic dimensions exist for postharvest situations in perishable crops, it is important that postharvest loss assessments and proposed actions incorporate economic analysis into technological assessments of the problem. Mere minimization of product losses is not <u>per se</u> desirable.

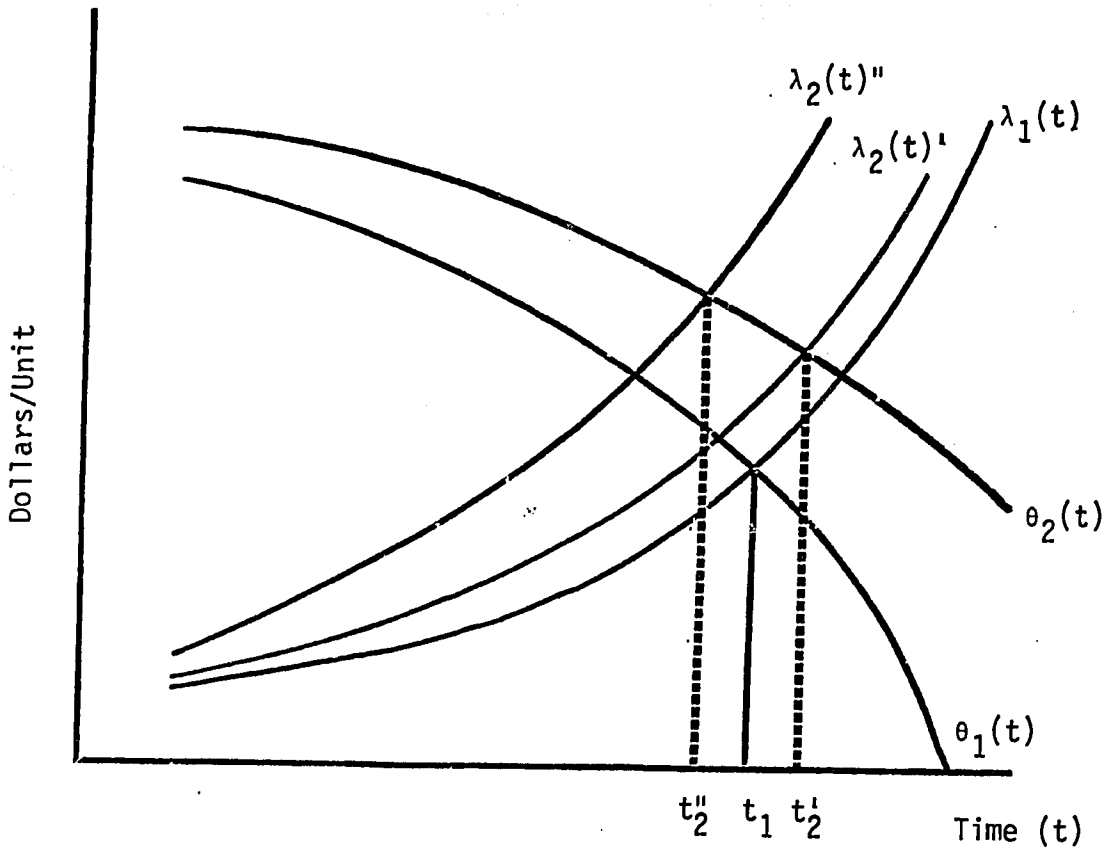



Figure 2. Costs, Technique, and Marketable Life of a Perishable Commodity.

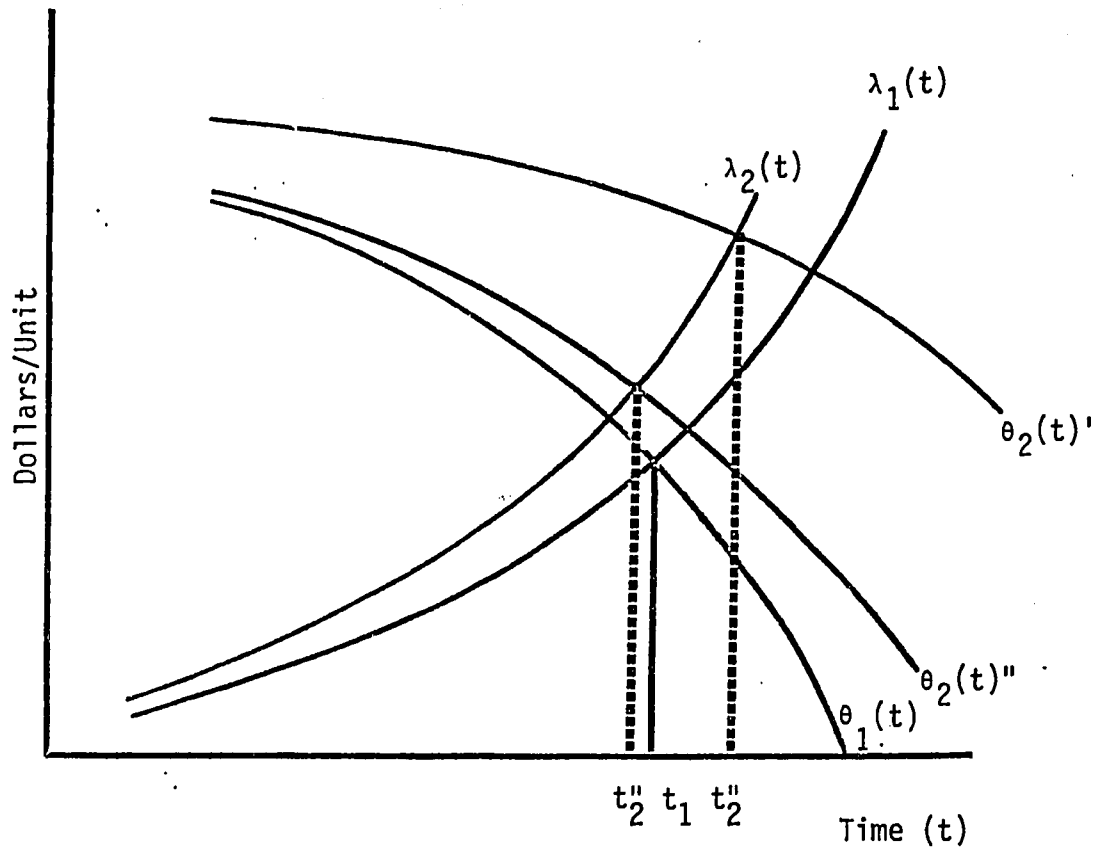



Figure 3. Market Response to Postharvest Innovation and Marketable Life.

d. Preharvest versus Postharvest

Separating preharvest and postharvest activities as though the two areas can be best studied and analyzed independently can be misleading. A principal cause of losses is the seasonality of production, which exists even in the tropics. Although vegetables can be produced all year, most countries have periods of scarcity and abundance with losses being significantly greater in periods of abundance. Plant breeding oriented towards extending growing seasons, improving heat tolerance and improving product characteristics such as durability, storage capacity, shelf life, and others can be helpful in lowering postharvest losses.

e. Methodology Applied in Taiwan

The methodological approach outlined above was applied in Taiwan. Considerable useful information regarding postharvest losses can be obtained over a very short period of time by an interdisciplinary team applying a systematic approach. The value of this information to the countries and their respective institutions responsible for solving the postharvest problems has not been determined. However, if the metnodological approach is refined in Taiwan, Taiwan could be used as a model and the methodology could be applied in other developing Asian countries.

3. Integrating Postharvest Activities

a. Role of National Institutions

The application of the methodology in Taiwan demonstrates the existence of an extensive institutional base with many subdivisions directly or indirectly involved in activities to control postharvest losses. Although most developing countries have fewer and less developed institutions, nevertheless they almost certainly have institutions involved with research, extension, training, planning, and marketing - the five principal components of a postharvest strategy.

Although it may be desirable in some instances to bypass governmental institutions and work directly with the private sector, vegetables are most frequently produced on small holdings by farmers with limited access

to information, credit, transport, infrastructure and technical assistance. Since these services are usually provided by government institutions, any attempt to control postharvest losses will likely have to be channeled wholly or partially through these entities.

b. Interinstitutional Coordination

There is often a lack of coordination between national institutions (the same might be said about international institutions). Two ways of obtaining coordination are:

1) Establish a full time coordinating body (which often turns into a bureaucratic maze)
2) Improve lines of communication so that entities with similar interests are kept informed of each other's activities. When one group becomes interested and has something to gain from another's activities, coordination takes place naturally.

Effective application of the methodological approach requires a strong commitment by and active participation of the host country national and their corresponding institutions so that the research effort:

1) Presents a realistic panorama of the actual situation
2) Is more easily communicated to decision makers
3) is accepted as an internal effort and not another "study" carried out by foreigners
4) Serves as the basis for the discussion and design of a national postharvest loss control strategy.

4. Results of the Application of the Methodology in Taiwan

Time did not allow a complete application of the methodology in Taiwan. However, some conclusions from the diagnosis can be made:

a. Institutional Diagnosis

1) A very complete and intricate institutional system exists in Taiwan which promotes overall agricultural development and serves to orient, coordinate, plan, finance, execute, and transfer actions to control postharvest losses.

2) Most institutions employ professional personnel of the highest caliber and they continue to send young professionals abroad for training in new priority areas of postharvest handling of perishables.

3) Postharvest activities are given high priority even though losses are considered to be relatively low. There is an attempt to anticipate a rapidly growing demand for more sophisticated food services.

4) Institutional needs from international organizations seem to be limited to information on advances in research and technology, training opportunities in U.S. universities, short-term consultancies in highly technical areas, and international market information.

b. Marketing Channel Diagnosis

1) The national postharvest people are fairly clear about the magnitude of food losses. They consider reducible losses to be relatively low.

2) The principal area where losses can be reduced is at the rural packing stage. If farmers are trained in grading and packing and if the regular use of the small cardboard container is assured, both food and time losses at the wholesaling stage can probably be reduced.

3. Given the close control that is maintained over the farmers' produce between farm and urban retailer, it is relatively easy to do a series of case studies to quantify actual losses under a variety of conditions and for many different products.

## RECOMMENDATIONS

The purpose of this project is to develop a methodological base for doing case studies in Indonesia, Thailand and the Philippines which would lead to the definition of AVRDC/PIP support activities. In this regard, the following recommendations are made:

1. AVRDC and PIP should continue developing their joint activities in three stages along lines summarized at the beginning of this report.
   a. Diagnosis of country situation
   b. Formation of a critical mass of manpower at country level
   c. Definition and execution of specific action where AVRDC and PIP can assist country efforts to control postharvest food losses.
2. Since time did not allow an active participation of Taiwanese nationals in the preparation of this report, and as it was not possible to observe the marketing/postharvest system in operation during the major production season (January-March), it is not possible to make final recommendations corresponding to Sections 5 and 6 of the proposed methodology. For complete application of the methodology in Taiwan, therefore, the following actions are suggested.
   a. AVRDC should circulate copies of this report to key persons in those institutions mentioned in the report.
   b. AVRDC should play a coordinating role in assisting one or more national institutions to organize a working meeting of 2-3 days to discuss the following subjects:
      1) Consumer demand for improved postharvest technology
      2) Capacity of farmer associations to meet the actual and future consumer demand
      3) Demand of the processing industry for improved postharvest technology
      4) Demand of the export industry for improved postharvest technology
      5) Role of the plant breeder in postharvest technology
      6) Need for new national policies to improve the postharvest handling of food commodities

c. Following the working meeting, a three-man commission should be assigned to prepare the conclusions of the working group. These conclusions and recommendations can be used to prepare Chapters 5 and 6 of Part Two of this report in which the components of a national postharvest strategy is outlined (Chapter 5), as are AVRDC/PIP support activities (Chapter 6).

3. Plans should be developed for case studies (as in Taiwan) in the Philippines, Indonesia, and Thailand. These diagnostic studies should form part of the AVRDC/PIP strategy as outlined for Stage I. These three case studies could be done by a two-man team (one agricultural economist and one technologist) over a one-year period as follows:

a. The AVRDC approach teams should make initial contact with representatives of national institutions. Official approval of the first visit should be obtained and dates set.

b. The two-man team should visit each of the three countries. The purpose of this visit is to undertake the institutional diagnosis (as in Taiwan), integrate a national postharvest support team, and organize the marketing channel/postharvest evaluation on the second visit. Prior to departure from each country, a working session should be organized to analyze situations and identify priorities.

c. The two-man team should then return to AVRDC to write the first part of the reports. (approximately two months).

d. During the peak vegetable production season, the two-man team should return to each of the three countries, do the field studies of postharvest losses, and identify the strengths and weaknesses of the marketing system (approximately three months). Working meetings should be organized in each country to evaluate results and suggest conclusions and recommendations.

e. When the two-man team returns to AVRDC, it should analyze and write final country reports and outline AVRDC/PIP support activities to each country and to the Asian region as a whole.

4. Because of the strong institutional base in Taiwan and the high level of expertise of professional personnel, these professionals should be involved in an Asian postharvest food loss control strategy. All indications are that in Asia there are experts of the highest level, willing and capable of participating in a program of reciprocal technical cooperation involving interchange of professionals between national institutions.

In the development of an AVRDC/PIP Asian strategy some possible actions should include the following:

a. PIP should intensify its efforts to create a human resource databank and give particular attention to postharvest experts in Taiwan, Japan and other Asian countries.

b. PIP could establish an Asian Station at AVRDC to coordinate the actions outlined under Stages I, II, III.

c. AVRDC/PIP might discuss with the ADB and other funding institutions the possibility of establishing a fund to finance reciprocal technical cooperation and other postharvest actions.

d. PIP should consider expanding its marketing expertise to satisfy country demands for a) information on standards and restrictions of potential markets; b) lists of contacts (importers and brokers) by country; and c) technical assistance in analyzing marketing systems and others.

e. PIP should publish a periodical newsletter on postharvest training opportunities in U.S. universities.

f. PIP should publish specialized bibliographies on such areas as a) rural processing technologies, b) grading and packaging, and c) marketing through farmer organizations.

g. AVRDC/PIP should promote the preparation of training materials which can be used by extension personnel in training farmers and traditional intermediaries in improved methods of postharvest handling of perishables.

h. AVRDC/PIP should stimulate universities to do more research into the economics of postharvest handling of perishables.

## E. INSTITUTIONS AND FIRMS VISITED

Silo Farmer's Association ((055)863631)

| | |
|---|---|
| Chief Ext. Section | Mr. Liaw, Bor-tyng |
| Ext. Specialist | Mr. Lin, Yih-sheng |

Shiwu Vegetable & Fruit Wholesale Market ((048)853421)

| | |
|---|---|
| Chief Sales Department | Mr. Yang, Leang-yuainn |

Hsinyi Farmer's Association ((049)791108)

| | |
|---|---|
| Ext. Specialist | Mr. Hwang, Cheng-yuan |

Provincial Department Agriculture & Forestry (PDAF) ((049)333751)

| | |
|---|---|
| Chief Dept. Transportation & Marketing | Mr. Lin, Jiunn-yann |

Plant Protection Center (PPC) ((043)302101)

| | |
|---|---|
| Director | Mr. Lee, Gwo-chin |

Taiwan Agriculture Research Institute (TARI) ((043)302301)

| | |
|---|---|
| Chief, Dept. of Extension | Mr. Tu, Jaw-ji |

Food Industry Research and Development Institute (FIRDI) ((035)223191)

| | |
|---|---|
| Ass. Director | Dr. Lee, Chin-fung |
| Post-harvest Specialist | Dr. Liu, M.S. |

Taichung District Agricultural Improvement Station ((042)225015)

| | |
|---|---|
| Vegetable Specialist | Mr. Song, Mike S. |

Yifung Fruit Co. (in Silo) ((055)862784)

| | |
|---|---|
| Middle man | Mr. Lin, Yi-fung |

National Chung-Hsing University ((042)246145)

| | |
|---|---|
| Department of Horticulture | |
| Dept. Head | Prof. Fan, Nien-tze |
| Vegetable Breeding | Dr. Chang, Wu-nan |
| Post-harvest | Mr. Horng, Deng Tseng |
| Dept. of Agricultural Marketing ((042)873181-333) | |
| Associate Professor | Mr. Yuan Shou-lien |

National Taiwan University ((02)3510231)

| | |
|---|---|
| Dept. of Horticulture | |
| Prof. Post-harvest | Prof. Chiang, M. N. |
| Assoc. Prof. Post-harvest | Dr. Lin, C. N. |

Taiwan Fruit & Vegetable Marketing Cooperation ((02)3018683)

| | |
|---|---|
| Chairman of the Board | Mr. Yu, Chung-chi |
| Chief Supply Section | Mr. Chen, Chung-nan |
| Sales Manager | Mr. Lee, Den-Rain |

Council of Agricultural Planning & Development (CAPD)

| | |
|---|---|
| Head, Dept. Farmers Assistance | Dr. Chen, S. Y. |

Foo Nan Agricultural Products Factory LTD & Trans-Tide International LTD.

| | |
|---|---|
| (Taiwan Fruit & Vegetable Export Company) ((062)365411) | |
| President | Mr. Lin, C. L. |
| Manager | Mr. Lin, Y. C. |

Yee Li Trading Co (Hong Kong Fruit & Vegetable Import Company)

| | |
|---|---|
| Managing Director | Mr. Allen Wong |

# PART TWO
# A CASE STUDY IN TAIWAN

## A. COUNTRY CHARACTERISTICS

Taiwan, Republic of China, is located in the subtropical zone and enjoys considerable sunshine and rainfall. The island measures 377 km from north to south and 142 km from east to west (at its widest point). Of the 36,000 sq km of land space in Taiwan, cultivated land covers about 25% of the total. Taiwan's population of slightly over 18 million on this small space results in one of the most intensive cropping systems in the world. Each hectare of cultivated land supports 20 people on the island. In 1980, there were 891,263 farm households with an average of 1.04 ha of cultivated land, each.

In recent years rapid industrial growth has created enormous changes in Taiwan's economic structure. The country is recognized today as one of the newly developed countries, a distinction achieved by relatively few countries in the past decade. Concomitant to the trend towards industrialization, agricultural population in the last 30 years has dropped from over 50% to approximately 30% of the total. Approximately 70% of the population now resides in urban areas. The share of net domestic product contributed by agriculture has declined from nearly 33% to less than 9%, and agricultural exports as a share of total exports have declined from 95% to only about 8%. However, these declines have resulted from rapid growth in the industrial sector and do not imply declining importance of the agricultural sector. The absolute value of both agricultural production and exports has increased during this same period. In 1982, total value of agricultural production was US $6.5 billion and the total value of agricultural exports was US $46 million.

## B. ECONOMIC AND AGRICULTURAL DEVELOPMENT POLICY

Industrial development has received much emphasis by policy makers in Taiwan. Economic growth averaged 8 percent during the Sixties and Seventies, and, despite depressed world conditions in the early Eighties, growth has continued at high levels. As part of a well developed industrial base, Taiwan's rail and highway networks are among the best in Asia.

Land reform, active producer involvement through producer associations, and planned economic development, including infrastructural improvements and technological innovations in agriculture, have been accompanied by increasing yields. From 1952 to 1981, total agricultural production increased by 185%. In its latest three-year program, which began in July 1983, the government plans to spend NT$80[1/] billion to strengthen rural infrastructure and increase incomes. The program will include steps to promote joint or custom farming and accelerate farmland consolidation. There are also plans to increase agricultural research, develop new cash crops, and continue training future farmers. The program will be augmented by price support and stabilization programs. In summary, although Taiwan has placed major emphasis on, and experienced considerable success in developing its non-agricultural industrial base, it is expected that agricultural production and marketing, including infrastructure for postharvest management, will continue to demand their share of research, education and investment. Heavy reliance upon producers' associations to implement future programs is expected.

## C. INSTITUTIONAL DIAGNOSIS

The purpose of institutional diagnosis is to identify and describe some of the principal characteristics of those national institutions responsible for providing services (technical assistance, information, training, research, extension, marketing, financing and planning) related in one way or another to the postharvest handling of basic food commodities. The institutions involved in such activities are listed in Table 1.

As shown in Figure 4, the principal institutions at the higher levels under the Taiwan Agricultural Administration Provincial setup are the Ministry of Economic Affairs (Bureau of Agriculture) and the Council for Agricultural Planning and Development (CAPD). Because the Bureau of Agriculture may integrate with the CAPD to eliminate duplication of functions, only the latter was included in the analysis.

Taiwan institutions and their involvement in postharvest activities follow.

1/ US$1.00 = NT$40.00

Table 1

Institutions in Taiwan with Post Harvest Related Activities

which were Included in Subsector Diagnosis

| Type Institution | Name | Location | Area of Influence | Type Post Harvest Activity |
|---|---|---|---|---|
| National planning | CAPD | Taipei | National | Planning, finance |
| Regional and International research | AVRDC | Tainan | International | Research, training |
| National research | DAIS | 7 locations | National | Research, extension |
| | FIRDI | Hsinchu | National | Research |
| | TARI | Taichung Hsien | National | Research |
| | PPC | Taichung Hsien | National | Research, training |
| Agricultural education | NCHU | Taichung | National | Teaching, research, extension |
| | NTU | Taipei | National | Teaching, research, extension |
| Agricultural development | PDAF | Taichung | National | Planning, research, training, extension |
| Farmers organization | PFA | | National | Credit, extension, planning training, marketing, processing, services |
| Marketing | TFVMC | Taipei | National | Planning, extension, wholesale auction, retail, storage, finance |

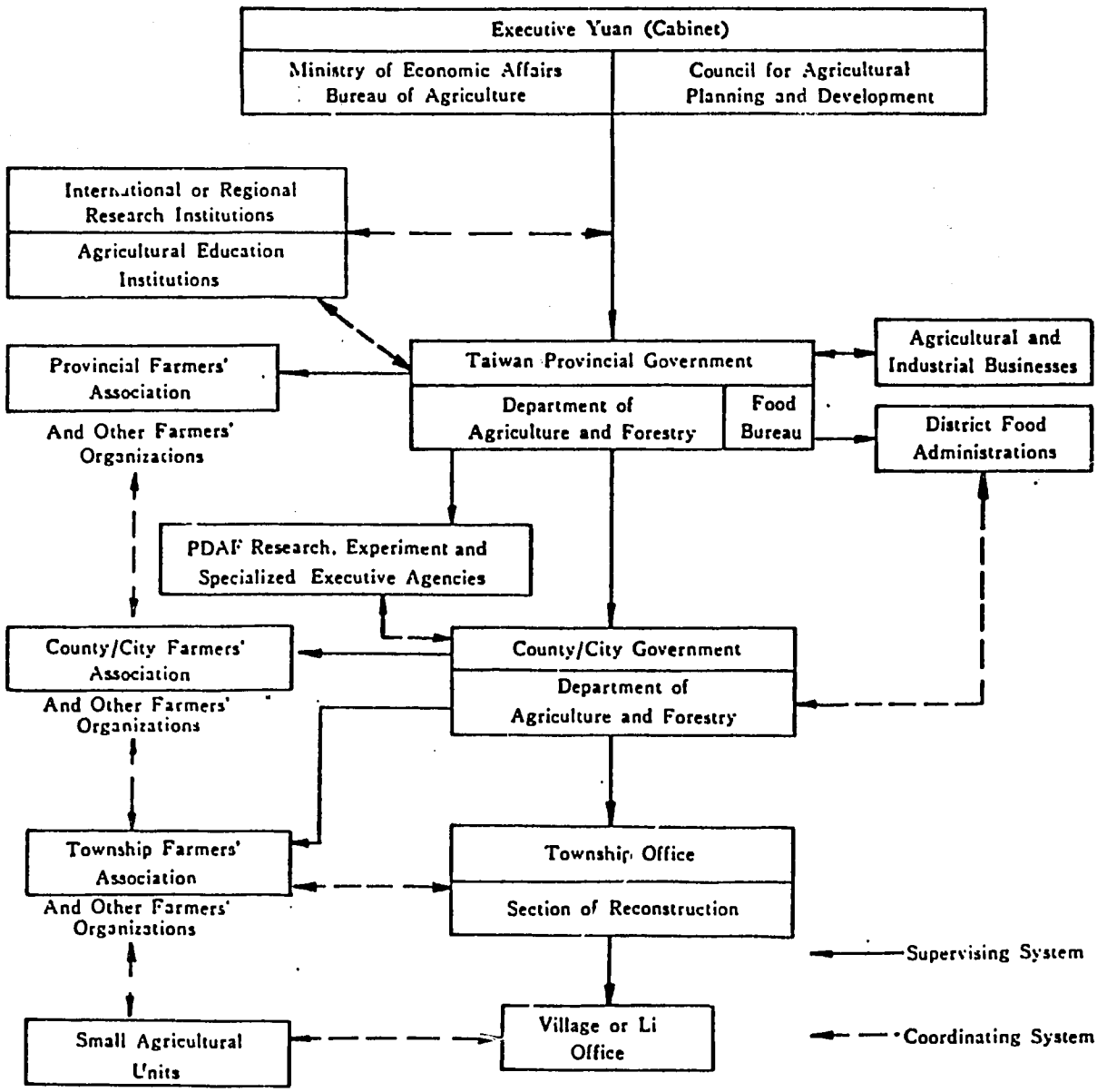



Figure 4: Agricultural Administration
Taiwan Provincial Structure

## COUNCIL FOR AGRICULTURAL PLANNING AND DEVELOPMENT (CAPD)

1. General Objectives:

Formulate, promote, coordinate and support development activities to benefit the rural population, particularly farmers.

2. Specific Objectives:

a. Promote the welfare of the largest number of farmers
b. Formulate, coordinate and support projects to satisfy needs felt by farmers
c. Stimulate farmer participation in associations and cooperatives
d. Strengthen the integration of interinstitutional development activities
e. Promote and finance innovative projects to improve production and marketing
f. Improve services to farmers by supporting the efforts of local governmental and other sponsoring agencies.

3. Priority Commodities:

Priorities change with production and marketing capabilities, and trade and political decisions. Priority is given to those products which are likely to increase returns to farmers and/or improve the balance of trade for Taiwan. In the past, priority has been given to mushrooms, asparagus, apples, pears, cabbage, lychee, grapes, and others.

4. CAPD Organization and Functions:

As defined by its organization rules, CAPD is an agricultural advisory, planning and coordination agency of the Executive Yuan (Cabinet) charged with the following tasks:

a. To study, analyze and propose agricultural policy
b. To formulate, integrate, compile and coordinate programs for aiding agricultural development and planning resource uses
c. To propose, coordinate, and provide technical assistance for special agricultural programs
d. To coordinate and support major agricultural projects implemented by government agencies at various levels
e. To study, plan, and coordinate matters related to the advancement of agricultural science and technology, international agricultural technical cooperation, and the training of agricultural personnel

f. To carry out other tasks assigned by the Executive Yuan.

At the next level are the International Regional Research Institutions. These, as shown in Figure 5, are divided into seven specialized institutes supported by enterprises or foundations and two regional institutes. Five institutes from the network of research and other institutes are included in the diagnosis:

DAIS: District Agricultural Improvement Stations
FIRDI: Food Industry Research and Development Institute
TARI: Taiwan Agricultural Research Institute
PPC: Plant Protection Center
AVRDC: Asian Vegetable Research and Development Center

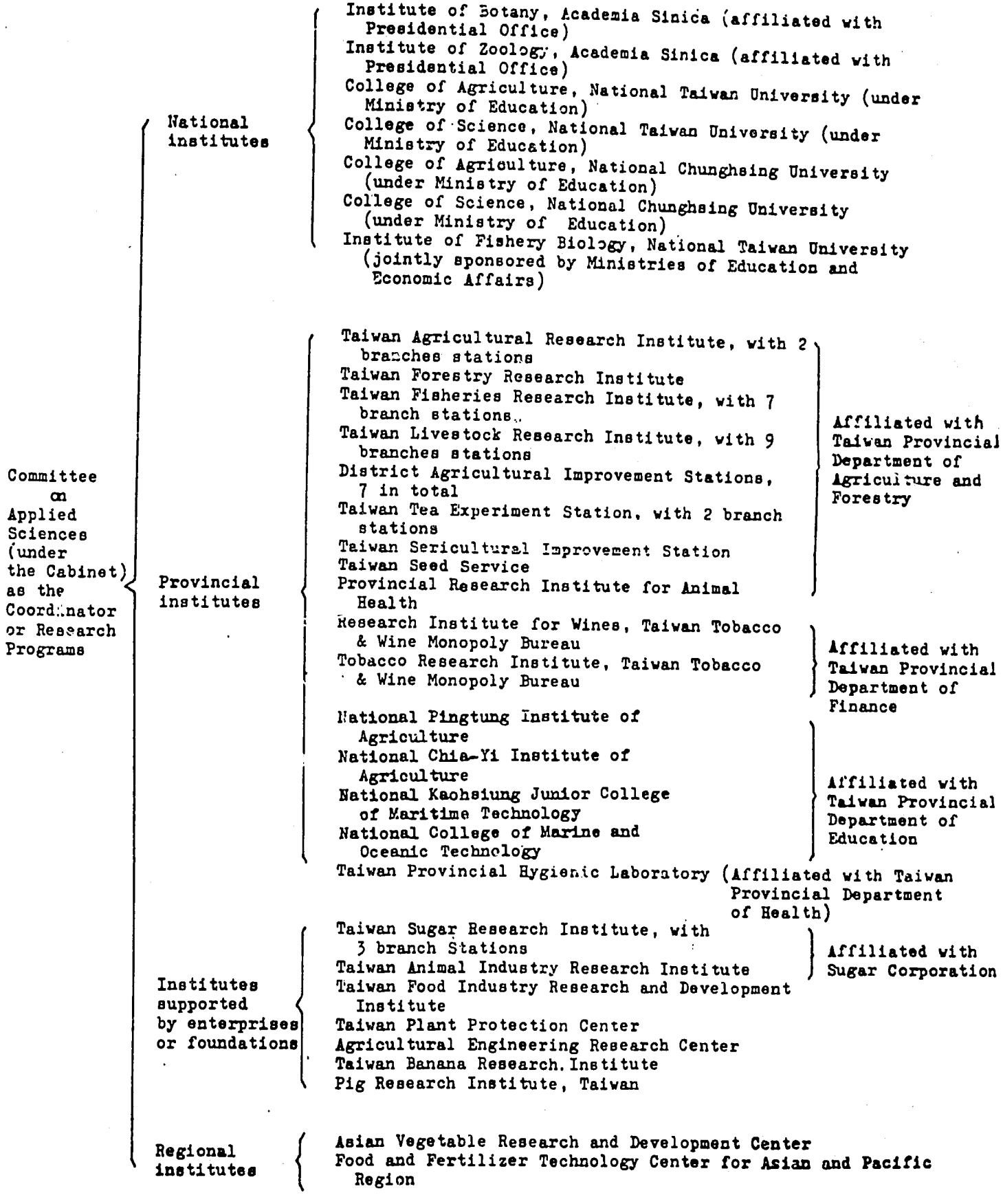
Two Agricultural Education Institutions are included:
NCHU: National Chun Hsing University
NTU: National Taiwan University

as are the:
PFA: Provincial Farmers' Association
PDAF: Provincial Department of Agriculture and Forestry

and the:
TFVMC: Taiwan Fruit and Vegetable Marketing Corporation

Table 1 summarizes basic information concerning type of institution, name, location, area of influence and type of postharvest activities done by these organizations.

Figure 5 System of Agricultural Research Institute in ROC



The Council headed by a chairman and a vice chairman, is assisted by a secretary-general, a number of consultants, and six departments in charge of economics and planning, agricultural resources, agricultural production, farmers' service, finance, and administration. The departments are further divided into twenty-two divisions responsible for specified functions.

5. Postharvest Activities

Current postharvest activities fall within two departments: Agricultural Production (Plant Industry and Food Processing Divisions) and Farmers Service (Farmers Assistance, Agricultural Marketing and Agricultural Trade Divisions).

a. Plant Industry Division

1) Coordinates the postharvest handling research activities in Taiwan
2) Supports research projects conducted in research stations and universities
3) Provides financial assistance to research stations for staff development on postharvest handling

b. Food Processing Division

1) Supports research projects on food processing
2) Provides financial assistance for infrastructure needed at research stations, universities and private enterprises
3) Promotes processing technologies developed by research projects
4) Helps processing industries promote their international market

c. Farmers Assistance Division

This division has 10 fulltime employees and the following functions:

1) Consolidating existing farmer associations and cooperatives through training, technical assistance, and financing special activities
2) Providing extension services in administration, technologies, marketing and finance
3) Promoting small farmer groups as extensions of farmer associations
4) Promoting farmer welfare activities, particularly home improvement loans

d. Agricultural Marketing Division

There are six full time professionals (one studying in the U.S.A.) in this Division. Their primary activities are:

1) Training farmers and product handlers (shippers) in agricultural marketing
2) Executing feasibility studies, including cost-benefit analysis for new markets
3) Developing improved techniques for grading and packing produce
4) Assisting in organizing farmers' groups for direct marketing in an attempt to improve their ability to compete as entrepreneurs
5) Providing financial assistance to university professors and students for marketing research

e. Agricultural Trade Division

This Division is relatively new (Feb. 1982); it has five persons, (three specialists and two assistants) and the following functions:

1) Investigates and makes recommendations to the Office of Foreign Trade on how to streamline imports of commodities such as corn and other feed grains
2) Assembles and publishes agricultural trade statistics of Taiwan
3) Intends to investigate potential new markets for fruit and vegetable exports.

6. Considerations Related to Postharvest Loss Reduction

a. CAPD is not a typical planning body but is involved in operational activities as well as those related to establishment of standards.
b. CAPD has been instrumental in providing new ideas and financing to initiate such innovations as improved packaging materials and marketing extension.
c. The Farmers Associations are viewed as the principal instrument in the transfer of ideas and technologies to the farmers. These associations have been responsible for reducing container sizes and introducing improved packaging and standardization of grades.
d. The CAPD is in a unique position to design, organize, and coordinate the implementation of pilot projects maximizing the active participation of public sector institutions and personnel.

# ASIAN VEGETABLE RESEARCH AND DEVELOPMENT CENTER (AVRDC)

1. General Objectives
   a. Improve the production of selected crops, i.e. tomato, Chinese cabbage, sweet potato, mungbean, and soybean in the humid and subhumid tropics
   b. Improve the nutritional quality of the crops
2. Strategy and approach
   a. AVRDC research involves specialists from various disciplines working together throughout the planning and execution stages of a particular project.
   b. AVRDC crops are introduced to national research programs to complement rather than replace staple crops. Hence, the cropping systems approach assumes major significance. National programs introduce AVRDC crops and management practices to local farmers through their own extension organizations. AVRDC's involvement is usually based on the needs and goals of the national program. The distribution of improved crop lines through national research organizations is an important part of the program. Every effort is made to identify cultivars adapted to specific environments. Graduates from the AVRDC training program also play an important role as liaisons between AVRDC and national research, development, and extension programs.
   c. Bilateral research programs have been established in the Philippines, Thailand, Korea, and the ROC. These programs develop a close relationship between AVRDC scientists and those in national programs. An AVRDC scientist is usually assigned to the national program for research consultations and project coordination.
3. Priority Crops

   Soybean, Mungbean, Tomato, Chinese cabbage, Sweet Potato
4. AVRDC Functions and Organization
   a. The function of AVRDC's administrative organization is to maintain an environment favorable to creative endeavor. It is designed to provide for the needs of various categories of staff so that they can devote maximum effort to their specific responsibilities with minimum diversions for administrative duties.

b. The Director of Administration, the Comptroller, and the three Program Leaders report to the Director General. Figure 6 shows the Center's table of organization and Figure 7 shows the AVRDC research and development system.

5. Postharvest Related Activities

Tomato:

a. Breeding for firmness
b. Breeding for fruit size
c. Evaluations on processing quality
d. Breeding for mechanical harvest
e. Breeding for heat tolerance

Chinese Cabbage:

a. Breeding for firmness
b. Breeding for head size
c. Breeding for heat tolerance

Soybean:

a. Variety development for frozen vegetable soybean
b. Variety and storage condition for processing
c. Evaluation of nutritional quality

Mungbean:

a. Breeding for uniform maturity for harvest
b. Breeding for improvement on protein nutrition quality
c. Storage for preventing insect damages

Sweet potato:

a. Breeding for staple and feed
b. Breeding for high B-carotene
c. Breeding for starch extraction
d. Breeding for storage quality

6. Considerations Related to Postharvest Loss Reduction

AVRDC attempts to eliminate the cause of postharvest problems. For example, hard tomatoes are less likely to be damaged than are softer varieties; uniform size fruit are easier to harvest, grade, and pack, so labor costs are reduced; improved processing characteristics increase consumer demand for a more manageable product; and heat resistant varieties extend production capabilities and reduce needs for storage. The plant breeding approach is oriented towards reducing postharvest problems through preharvest scientific applications. Although this type of research is time consuming in the developing stage, the results can be rapidly transferred with far reaching impact. Also, once innovation is developed, it can be introduced at very low or zero costs to farmers and marketing intermediaries.

Figure 6 AVRDC Table of Organization

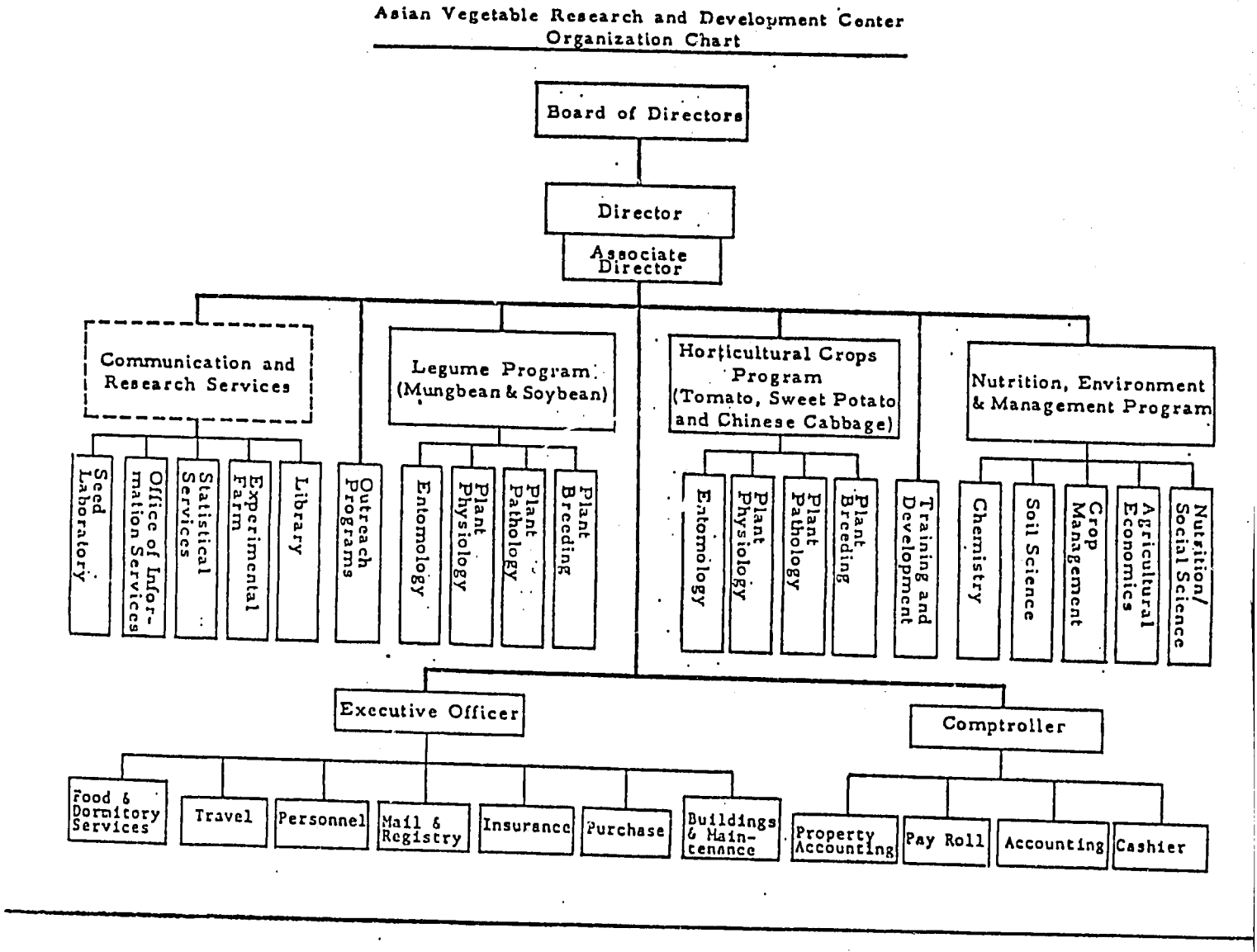
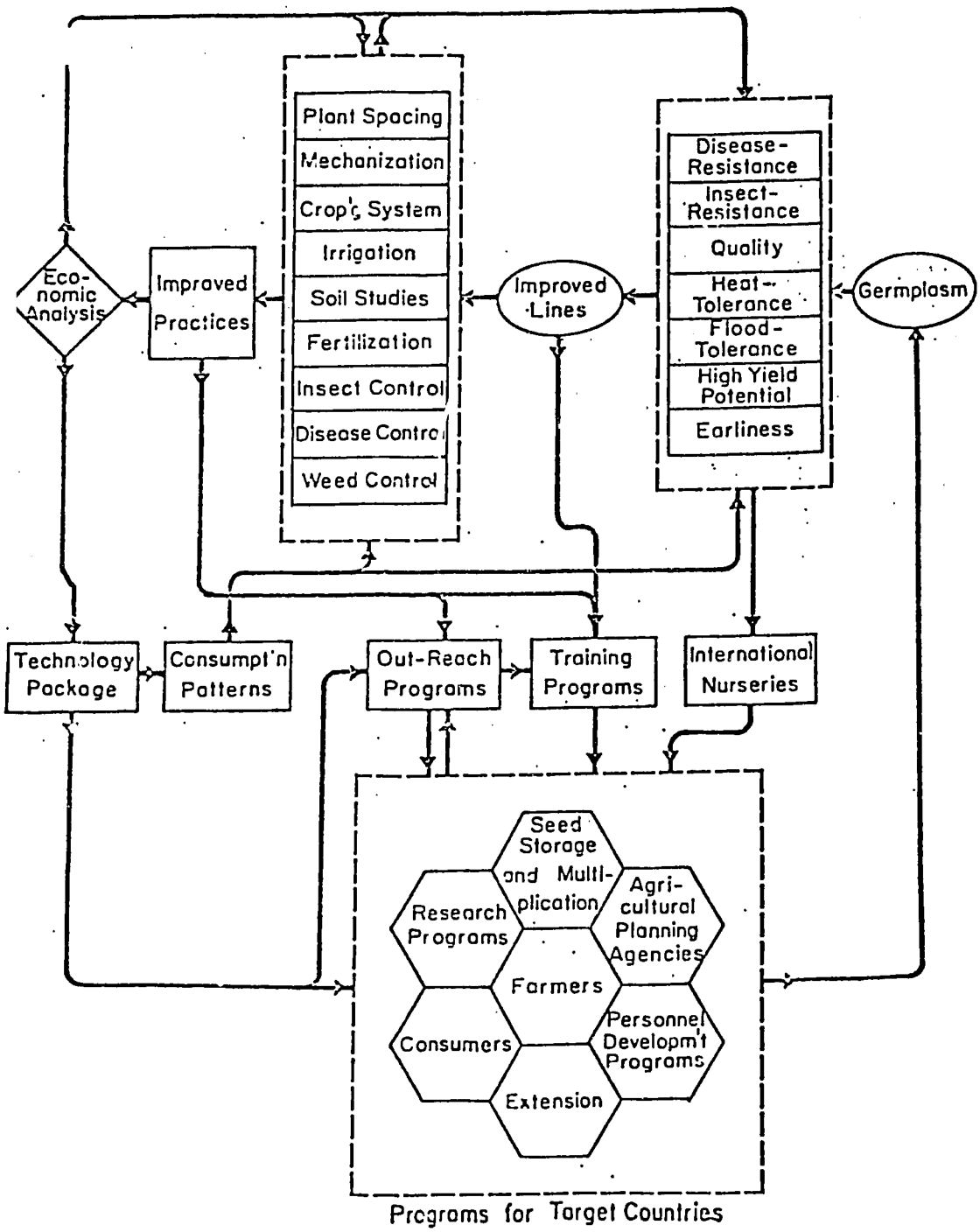


Figure 7 AVRDC Research & Development Scheme



## DISTRICT AGRICULTURAL IMPROVEMENT STATION (DAIS)

1. Overall Objective

The agricultural improvement station does agricultural experiments and practical research on products emphasized in its district of responsibility. There are seven districts. DAIS concentrates on the applied aspects of research more than do the universities and research institutes.

2. Specific Objectives

   a. Improve crop yields and develop new cash crops
   b. Develop improved or new mechanized devices to be used in agricultural production
   c. Reduce postharvest losses

3. Priority Commodities

   a. Rice
   b. Horticultural crops including pears, strawberries, flowers, grapes, citrus, cabbage, and others.
   c. Other cash and specialty crops

Each district experiment station concentrates on crops in which its geographical locality specializes, e.g. Taipei -- fresh vegetables, summer vegetables and fruit; Tainan -- tomato, asparagus, carrot; Taichung -- grapes, pears, citrus; Kaohsiung -- onion, vegetable soybean, asparagus, watermelon.

4. Organizational Structure

There are seven district agricultural improvement stations under the authority of the Provincial Department of Agriculture and Forestry.

5. Principal Postharvest Activities

While the DAIS's traditionally do experiments and research relating to postharvest problems of rice, they have only recently begun to move into postharvest activities relating primarily to perishable fruits. More emphasis is being placed on postharvest not because of quantitative physical losses per se, but because domestic consumers are demanding higher quality products as their incomes increase. Also, postharvest considerations are important in developing export markets. Personnel are being trained in programs in California to enhance the capability of DAIS in postharvest work. Training programs administered by the stations in postharvest problems of perishables have been limited to date since

research is only beginning. The DAIS's are attacking preharvest problems that cause postharvest economic losses, primarily those from excessive production during winter months and scarcity and corresponding high prices during the summer. Some of the areas of research oriented to resolve this problem include:

a. Use of chemicals to extend shelf life of pears, grapes, and citrus
b. Processing and canning of lychee
c. Use of chemicals which keep fruit from dropping from tree or use of chemicals to hasten or delay maturity
d. Use of defoliants to get two crops of grapes per year
e. Development of fruit varieties which mature out of season
f. Planning production in non-traditional areas with different climatic conditions

These types of research are done in conjunction with university professors. Once the postharvest technology is developed at the DAIS, it organizes training programs with local officials and farmers to transfer the techniques to actual applications. The methods used for this transfer include seminars, short courses, night meetings with farmers, publications in farmer magazines, visual aids, field trips, demonstration plots, and pamphlets. All of the transfer activities take place through Farmer Associations.

## FOOD INDUSTRY RESEARCH AND DEVELOPMENT INSTITUTE (FIRDI)

1. General Objective

FIRDI does basic and applied research on food preparation, storage, packaging, and processing problems to improve the quality of food and the efficiency of food processing and packaging and to develop new products.

2. Specific Objectives
   a. Improve food packaging
   b. Develop highly processed prepared food
   c. Improve storage capabilities
   d. Improve and develop automation and machinery to prepare food of higher quality and cheaper cost
   e. Promote food safety
   f. Improve food supply and distribution systems
   g. Provide technical services and training
3. Crops Given Priority
   a. Rice
   b. Mushrooms
   c. Vegetables (including asparagus, cabbage, Chinese cabbage, bamboo shoots)
   d. Fruits (including lychee, papaya, mango)
   e. Pork products
   f. Fish products
   g. Other (soybeans, peanuts)
4. Organizational Structure

FIRDI in 1982 had a total of 134 employees including 77 technical professional staff, 30 administrative staff, 9 technicians, and 18 workers. The institute is organized under the directorship of Paul C. Ma (who is also chairman of the Board of Directors of AVRDC) into a Division of Food Science broken into six working groups (postharvest handling, flavor chemistry, grain science, analytical method development, food microbiology, and industrial microbiology) and a Division of Food Technology broken into seven working groups (can corrosion and chemical contamination, packaging, canning, dehydration, refrigeration, food machinery, and edible oils and fats), plus sections concerned with economics and statistics, and training and technical service.

5. Principal Postharvest Activities

FIRDI focuses almost exclusively on postharvest questions in the Taiwan agricultural industry. In 1982 FIRDI reported results from a study to improve the quality of tin cover, on studies of flexible food packaging materials, and on studies for storing lychee, cabbage, and Chinese cabbage. Experiments on respiration measurements of fruits and vegetables were started in 1980 to study ways of keeping the respiratory activity of fresh fruits and vegetables as low as possible without inflicting damage. Nine different fruits, including carombola, loquat, wax apple, lychee, guava, pear, mango, and persimmon were investigated in 1981 and similar experiments were applied to fourteen other different fruits and vegetables produced in Taiwan in 1982. Results were reported for sugar apple, indian-jujube, several varieties of citrus fruit, bamboo shoots, pineapple, grape, ginger, and shallot. Other programs in progress include bulk storage of potatoes at low temperatures, starch biosynthesis in sweet potatoes, and postharvest handling and storage of bamboo shoots.

## TAIWAN AGRICULTURAL RESEARCH INSTITUTE (TARI)

1. General Objective:

TARI does both basic and applied agricultural research to help solve various crop production problems and enhance agricultural production and development in Taiwan.

2. Specific Objectives

Find and develop new methods of field and horticultural crop production through research to:

a. Increase yields through plant improvement, soil improvement, disease and insect control, or other means.
b. Develop improved agricultural machinery used in transplanting, cultivating, weeding, and harvesting, and improved mechanical methods for drying, storing, and distributing agricultural products
c. Reduce postharvest handling and processing problems.

3. Crops given priority

a. Staple crops including rice and dryland crops (soybean, corn, peanut, sweet potato, and wheat).
b. Horticultural crops including fruits (citrus, pineapple, mango, lychee, longan, guava, papaya, pears, and passion fruit.) Vegetable crops (cabbage, kale, broccoli, green pepper, egg plant, cucumber, onion, watermelon, beans, and peas) and ornamental plants.
c. Special crops (medicinal herbs, cover crops)
d. Fiber crops

4. Organizational Structure

The institute was established under Japanese rule in 1895. Since 1958, when a separate Taiwan Livestock Research Institute was formed, the institute has worked exclusively with plant agriculture. The headquarters of TARI is located in Wufeng, Taichung in central Taiwan, about a two hour drive from AVRDC. The headquarters occupies 145 ha of land and comprises four laboratory buildings, an administration building, and various green houses and auxiliary buildings; also, the institute has 128 ha of its Taichung grounds as an experiment station plus two branch experiment stations: the Chiayi Agricultural Experiment Station and Fengshan Tropical

Horticultural Experiment Station. The present staff of the institute numbers around 130 scientists and 80 research assistants and over 250 farm laborers. There are six main divisions of research in the headquarters of the institute: the Departments of Agronomy, Horticulture, Agricultural Chemistry, Plant Pathology, Applied Zoology, and Agricultural Machinery. The Department of Horticulture has laboratory equipment and staff personel assigned specifically to postharvest handling and processing problems of fruit and vegetable crops.

5. Principal Postharvest Activities

Efforts to prolong citrus life and to even out the product volume of vegetables throughout the year are priority areas of research at the Institute. Postharvest handling and processing research is still limited in scope. However, major efforts have been directed to improving handling, and transit and storage technologies for grape, lycnee, and water chestnuts. Improved methods of processing juices from citrus, mango and passion fruit, and preserving pineapple, dates, and sweet potatoes in various forms are also reported to be in progress. Studies on quality and storage of domestic and imported apples, storage of cabbage and Chinese cabbage, effects of controlled atmospheric storage, date of harvest, storage temperature, the effect of packaging material on the decay and quality of oranges, tomato variety ripening comparisons of changes in respiration, ethylene evolution, peroxidase activity, use of a permeable film package to control the atmosphere of green mature bananas and tomatoes, transit and storage methods of lychee, and other studies have been reported by Dr. Shui-cheng Lin and other postharvest specialists in TARI from the early 70's to the present. The postharvest projects at TARI include handling, storage, and transit of export fruits and vegetables; bulk storage of potatoes at low temperature proper storage temperature of selected tropical vegetables.

## PLANT PROTECTION CENTER (PPC)

1. General Objective

PPC's principal objective is to help solve various plant protection problems in Taiwan through basic and applied research and to provide technical training and education.

2. Specific Objectives

a. Examine and assess current practices and problems of plant protection with a view to developing better and more effective measures for the control of important plant diseases, insect pests, rodents and weeds on the island

b. Assist the government in implementing the Pesticide Control Act promulgated in 1972, particularly with respect to the determination of tolerances for individual pesticides through detailed studies on the distribution and degradation of pesticide residues under local conditions

c. Search for improved methods of plant protection (including biological control) and their integrated application to avoid over-dependence on the use of chemicals

d. Explore other possibilities to minimize the pesticide residue problem so that all locally produced food, feed crops and food products will continue to be completely safe for human and animal consumption and for export

e. Provide various forms of technical in-service training for plant protection workers in Taiwan, in cooperation with the agricultural colleges and other research institutes.

f. Train future senior researchers in the field of plant protection by providing selected promising research workers of the Center with opportunities for advanced study and training abroad

g. Cooperate with agricultural colleges and other research institutes in Taiwan for coordinating plant protection research so that respective programs will complement one another

h. Maintain a high standard of plant protection research in the country by arranging invitational visits of foreign scientists and appropriate cooperation with prominent research institutes in other countries

3. Crops Given Priority

   a. Rice
   b. Export crops such as asparagus and mushrooms
   c. Fruits and vegetables
   d. Frozen pork exports

4. Organizational Structure

The Board of Directors of the Center is composed of seven members including one from each of its three funding agencies, CAPD, the Ministry of Economic Affairs, and the Taiwan Provincial Government. The research program is conducted under the general supervision of the Director, Dr. G.C. Li. Research programs are organized into five divisions: Pesticide Residue, Pesticide Toxicology, Entomology, Plant Pathology, and Plant Physiology. The center has a total research staff of 38, six of whom hold Ph.D.s.

5. Principal Postharvest Activities

PPC's principal involvement with postharvest activities is to determine whether the use of chemicals, i.e. insecticides, fungicides, and preservatives, is effective, whether their use poses risks to consumers; and whether they meet local regulations and standards. Research and training programs have emphasized residue questions. Some work has been devoted to export crops such as asparagus and mushroom. No specific department is assigned postharvest activities as a major responsibility, although the Pesticide Residue Division is particularly relevant to postharvest treatment activities in that it clears registration of fungicides and preservatives used in postharvest treatment.

The principal postharvest related activities can be summarized as follows:

   a. Approve chemicals for agricultural use for national registration
   b. Evaluate the impact of chemical residues on humans and wildlife
   c. Identify ways of controlling imports through non-tariff barriers such as import restrictions on insect contamination, disease, mycotoxins, or residues
   d. Study insect pests in stored grains
   e. Evaluate chemical treatment of agricultural commodities for export
   f. Study disease problems of export crops, e.g. anthracnose in mangos
   g. Screen herbicides

6. Considerations Related to Postharvest Losses:

   a. Many chemicals are now being used on an economic or trial basis to extend the storage life of perishable commodities - whether on the tree, in the field, in controlled storage or on the grocer's shelf. In some cases, because the increased return justifies the added costs, the techniques are adapted to increase market opportunities

   b. Excessively high levels of pesticide residues can lead to postharvest economic losses, particularly when the product is exported without adequate controls. Also, the consumption of contaminated foods can lead to losses in human capital.

## NATIONAL CHUNG HSING UNIVERSITY (NCHU)

1. General Objectives

NCHU is a comprehensive university offering undergraduate and graduate education programs and doing research in the agricultural sciences and other areas of higher education, including the liberal arts, law, commerce, science, and engineering. Its general objective is to transmit and expand knowledge in these areas.

2. Organizational Structure

National Chung Hsing University has its main campus located in Taichung near the Taiwan Agricultural Research Institute and about a two-hour drive from AVRDC. Originally chartered as an advanced academy of agronomy and forestry in 1919 during the Japanese occupation, the university on the Taichung campus is now organized into four academic colleges: Liberal Arts, Law and Commerce, Agriculture, and Science and Engineering. Within the College of Agriculture there is an administrative division which includes: Research Institute of Food Crops, the Departments of Agronomy, Horticulture, Forestry, Agricultural Economics, Agricultural Marketing, Plant Pathology, Animal Husbandry, Veterinary Medicine, Soil Science, Agricultural Education, Soil and Water Conservation, Food Science, and the Division of Agricultural Machinery. Most faculty time is divided between teaching and research activities.

3. Principal Postharvest Activities:

Postharvest teaching and research activities concerned with perishable products at NCHU are primarily housed in the College of Agriculture within the Department of Horticulture and Research Institute of Horticulture and the Department of Agricultural Marketing. Additional expertise and services can be drawn from other academic units, including the Department of Agriculture and supporting departments in other colleges.

Specific courses dealing with postharvest questions offered in the Department of Horticulture include "Processing of Horticultural Products" and "Handling of Horticultural Products" at the undergraduate level, and graduate courses in "Postharvest Disease," "Postharvest Physiology," and

"Special Topics in Handling of Horticultural Products." Within the Department of Agricultural Marketing, courses include "Marketing of Horticultural Products," "Packaging," and "Transportation Economics." Considerable emphasis is apparently given to postharvest aspects of agriculture at NCHU as it is unusual to have a separate academic department in agricultural marketing.

Postharvest research activities at NCHU include studies on packaging, transportation and storage of waxapple and onions, and effects of gas composition in package containers on the transit quality of plums. Faculty at NCHU who are associated with postharvest questions tend to divide their time evenly between research and teaching, although in certain instances faculty are involved in extension activities.

## NATIONAL TAIWAN UNIVERSITY (NTU)

1. General Objective

National Taiwan University's primary objective is to offer undergraduate and graduate instruction for the education and training of Taiwanese and to do basic and applied research.

2. Organizational Structure

National Taiwan University is located in Taipei. It is Taiwan's largest university with 6 colleges and 42 departments. At present the College of Agriculture has twelve departments: Agronomy, Agricultural Chemistry, Agricultural Engineering, Plant Pathology, Entomology, Forestry, Husbandry, Veterinary Medicine, Agricultural Economics, Horticulture, Agricultural Extension, and Agricultural Machinery Engineering. With the exception of the Department of Agricultural Machinery all of these departments have masters graduate programs and some, including the Department of Horticulture, offer Ph.D. programs.

3. Principal Postharvest Activities

In the Department of Agricultural Economics the course "Horticultural Products Marketing" includes certain postharvest subjects related to perishables. The Department of Horticulture is the principal location for activity on postharvest perishables. This department with its attendant graduate institute consists of six divisions, two of which deal directly with postharvest issues, namely the Processing of Horticultural Products and Handling Division, and the Transit and Storage of Horticultural Crops Division. Specific postharvest courses include "Handling, Transportation & Storage of Horticultural Crops" in the undergraduate program and "Advanced Postharvest Physiology of Horticultural Crops" and "Advanced Processing of Fruit" in the graduate program. Related courses in biochemistry, chemistry, and physiology are offered to support a postharvest educational background in horticulture. A Graduate Institute of Food Sciences and Technology was established in 1976 to educate the research and technical personnel for Taiwan's food industry, and courses are to be offered in food processing technology, food engineering, advanced food chemistry, food microbiology, food packing, quality control

in food processing, and food processing machinery design. NIU does research at both the basic and applied level that directly or indirectly relates to postharvest questions of perishable fruits and vegetables. Marketing cost analysis of fruit and vegetables has been done in the Department of Agricultural Economics. Postharvest related research projects on fruits (bananas, citrus, and grapes) and on vegetable products have been done in the Department of Horticulture. Other pertinent research has been done in different departments of the College of Agriculture as well as in other colleges.

## PROVINCIAL DEPARTMENT OF AGRICULTURE AND FORESTRY (PDAF)

1. General Objective

Ensure increases in farm incomes, agricultural growth, and rural living standards.

2. Specific Objectives

a) Promote joint or custom farming and implement farm mechanization

b. continue planned production and marketing practices, maintain price supports for farm products, and create funds for food stabilizatio and agricultural development

c. Accelerate agricultural research and develop new cash crops or farming operations

d. Train future farmers and promote farm sidelines

e. Boost investment in infrastructural installations and accelerate farmland consolidation

f. Increase medicare and utility services

g. Improve living and environmental facilities

h. Add athletic, cultural and recreational facilities

i. Strengthen community development through popular participation and cooperation.

3. Priority crops

The PDAF is presently giving priority to the following crops: citrus, banana, pineapple, tomato, common cabbage, asparagus, mushrooms, and flowers.

4. PDAF Functions and Organization

Responsible to the Governor of Taiwan Province for agricultural administration, the Department of Agriculture and Forestry is in charge of:

a. Formulating and managing plans for crop, forestry, fishery, and livestock production

b. Promoting research, experiments and development in the fields of crops, forestry, fishery, and livestock

c. Promoting the multiplication, demonstration, extension, and improvement of superior crop and livestock breeds

d. Improving the production and marketing techniques of crops and livestock products

e. Improving plant protection techniques and supervising the production and marketing of agricultural chemicals

f. Doing agricultural economic surveys, agricultural extension education programs, and assistance to farmers' organizations

g. Supervising the conservation and development of mountain slope land.

The organizational structure of the Provincial Department of Agriculture and Forestry is shown in Figure 8.

5. Postharvest Activities

Four divisions work in the postharvest area: Special Crops, Agricultural Marketing, Food Crops and Farmers' Service.

a. Special Crops Division

Most of the postharvest activities of this division have been transferred to the Agricultural Marketing Division; however, the division does experiment with the use of chemicals to prevent ripening and extend shelf life and it promotes investigation into canning pineapples, mushrooms, and other perishables. Most of its activities are related to the identification of priority problems at the farm level and the institutions most capable of solving the problems. It has some research funds for financing activities or research institutions and it plays an interinstitutional coordinating role in the transfer of pre- and postharvest technologies to farmers.

b. Agricultural Marketing Division

This Division has a permanent staff of 32 persons plus a few more (3-5) working on special projects. Three members of the staff have training in postharvest handling of perishables. One has a MS in Agricultural Economics and one year at Cornell. Another is going to Cornell this year. Its principal activities include the following:

1) Planning

Planning is twofold. First, emphasis is given to advising farmers through the extension system on the benefits of production planning to reduce wide seasonal variations; secondly, technical assistance is provided to farmers' organizations to prepare projects for basic infrastructure (markets, assembly centers, or cold storage facilities) and improved equipment (trucks, carts, lift forks, or others).

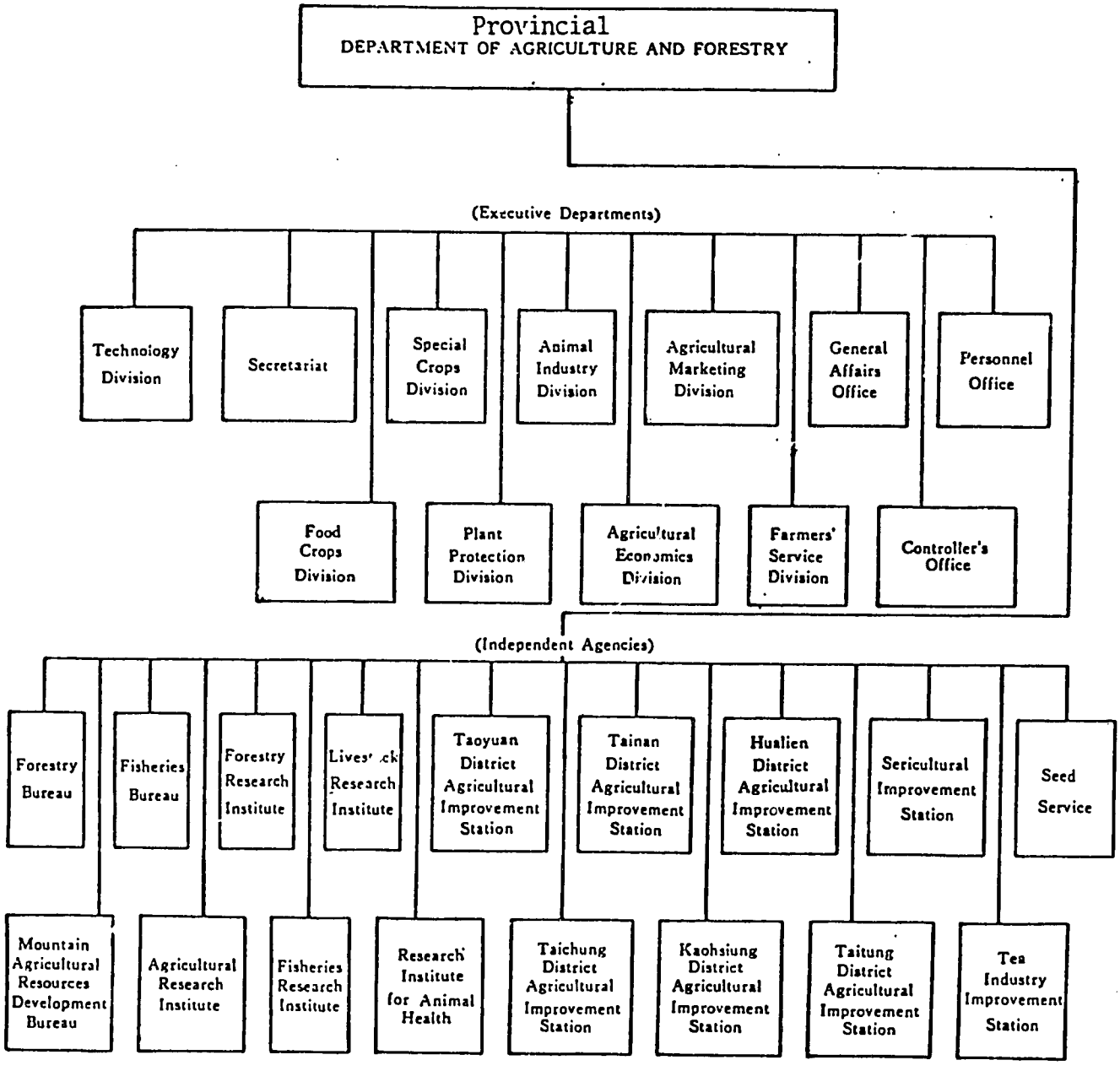



Figure 8: Organizational Chart Provincial Department of Agriculture and Forestry

2) Training

Training is oriented towards extension staff as well as to farmers. Areas of training include:

a) Improved methods of production planning for approximately 20 products

b) Postharvest handling of perishables, particularly grading and packing at the farm level

c) Product marketing and financial administration

d) Consolidation of farmers' associations to facilitate farmer involvement in direct marketing.

3) Investigation

Most of the investigation is market oriented, concerned with sales volume, prices, and cost analysis of marketing costs and margins.

4) Transfer

Since all villages have telephones, 80% of the farmers have TV, and an extensive system of farmer associations exists to channel institutionalized services to farm families, the principal methods of transfer of information and new ideas are:

a) Publishing information in farmer magazines

b) Broadcasting radio and TV programs oriented to the farmer

c) Distributing extension pamphlets distributed through farmers associations and farmer group leaders.

d) Making public announcements by group leaders over village loud speaker system

e) Providing field demonstrations to groups of farmers

c. Food Crops Division

The principal postharvest activity of this division is the design of research projects to be done by other institutions, e.g., solar dryers for sweet potatoes for use as animal feed.

d. Farmers Service Division

This division works closely with farmers' associations and is responsible for the planning and supervision of their activities and the organization of actions related to home economics, nutrition, rural sanitation, and others.

6. Considerations Related to Postharvest Losses

a. There is a general feeling that postharvest losses are high (40%) if outside coverings of vegetables are included; however, if coverings are not included, losses are believed to be less than 10% for all types of loss, including shrinkage and quality. Stored vegetables such as fruit, onions, and potatoes probably suffer less than 10% loss over a 3-month storage period. Because little scientific research has been done on losses, these percentages can be considered educated. but valid guesses.

b. Although quantitative losses are considered to be relatively low, postharvest technology is a priority area because consumer demand is becoming more and more sophisticated. As demand for quality produce increases, new technologies can be introduced which will reduce losses, even if only slightly. It is possible that when increased consumer demand forces prices up, it is economically viable to introduce new technology because the added costs are less than the added returns.

c. Farmers have become much more aware of the importance of good postharvest handling techniques; however, they still have much to learn, particularly in handling fresh vegetables. It would, therefore, be useful to improve the quality of extension material for postharvest handling of perishables as well as the methods for the transfer of information and technologies to the farmers.

## PROVINCIAL FARMERS ASSOCIATION (PFA)

1. General Objective

To assure farmers' rights and interests and to advance their knowledge and skills, to promote modernization in agriculture, to increase net income and in general to improve the farmers' lives and the rural economy.

2. Specific Objectives

a. Secure farmers' legal rights through dissemination of agricultural laws/regulations and arbitration of disputes
b. Assist in improvement of land and water conservation
c. Facilitate agricultural extension, training and improved use of seed varieties, breeding, and use of chemical fertilizers
d. Improve the efficiency of farm labor and mechanization
e. Formulate and implement improved farming schemes
f. Promote improved marketing, storage, processing, manufacturing of farm products, and operation and management of wholesale markets for farm products
g. Study the procurement, allocation, processing, and manufacturing of farming inputs and daily necessities for members
h. Provide and/or facilitate services such as credit, insurance, social welfare services, and disaster relief

3. Priority Crops

The priority crops vary with the location of the Farmers' Association and include all commodities of importance in Taiwan, such as rice, sugarcane, mushrooms, asparagus, fruits, vegetables, ducks, chickens, hogs, cattle, onions, honey, flowers, and others.

4. PFA Organizational Structure

The PFA is linked to the PDAF as indicated in Figure 9. Below PFA are the county/city farmers' associations and the township farmers' association.

There are five sections in each township farmers' association, namely the sections of economics, credit, extension, administration, and accounting section. The county and city farmers' associations have economic, extension, administrative, and accounting divisions. The

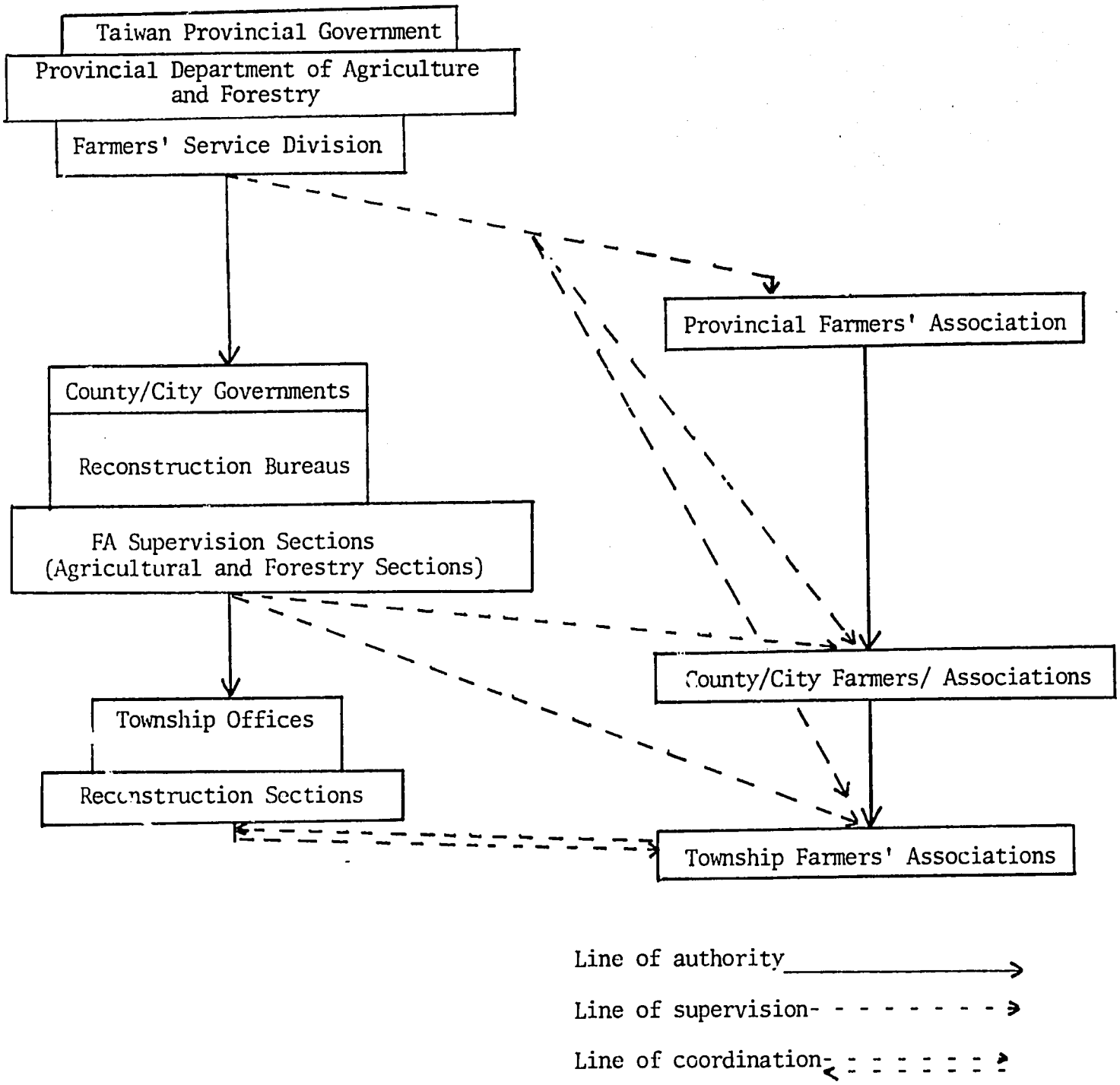



Figure 9: System of Supervision for the Farmers' Associations in Taiwan

Provincial Farmers' Association has an economic department, an agricultural extension department, a field supervision department, an administrative department, an accounting department, and a training center.

All the township associations in the same county or city are members of the county or city association, and similarly all the county and city associations are members of the provincial association. The township association is, therefore, a vital link in the whole structure of the farmers' association system. It maintains a direct contact with the farmers and serves them. The major function of the provincial and county associations is to coordinate and supervise the programs of work undertaken by the township associations.

The power of a farmers' association is vested in the meetings of the representatives of its members (Figure 10). The representatives are elected by the lower levels of the farmers' associations or by the small agricultural units. Each farmers' association has a board of directors and a board of supervisors. The major function of the board of directors is policy making, and that of the board of supervisors is auditing. A general manager is appointed by the board of directors to operate the services of the farmers' association.

A typical TFA has approximately 60 representatives of the members, 9 members on the Board of Directors and 3 on the Board of Supervisors. The number of employees under the General Manager includes roughly 5 in the Administrative Section, 50 in the Economic Section, 45 in the Credit Section, 12 in the Agricultural Extension Section, and 5 in the Accounting Section.

Figure 11 shows the importance of the PFA in Taiwan as some 900,000 households are represented at the three distinct levels: township, county and province.

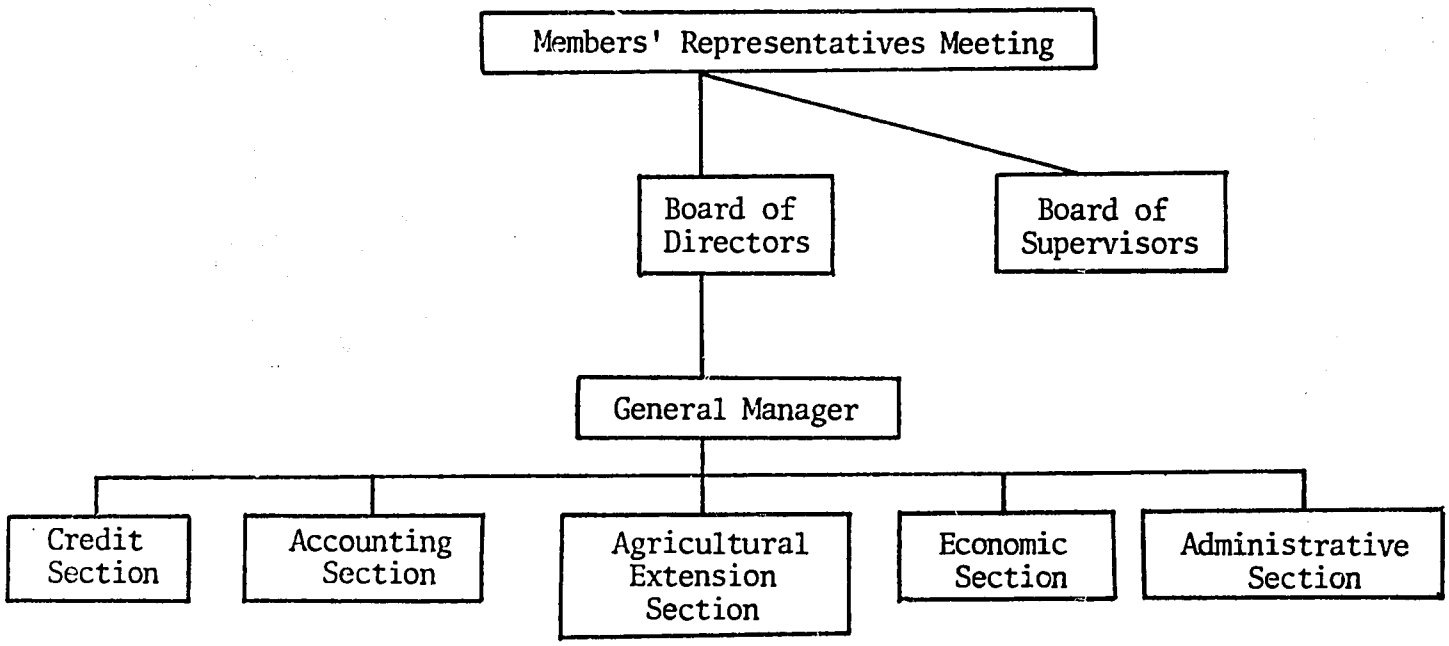



Figure 10: The Organizational Chart of a Township Farmers' Association

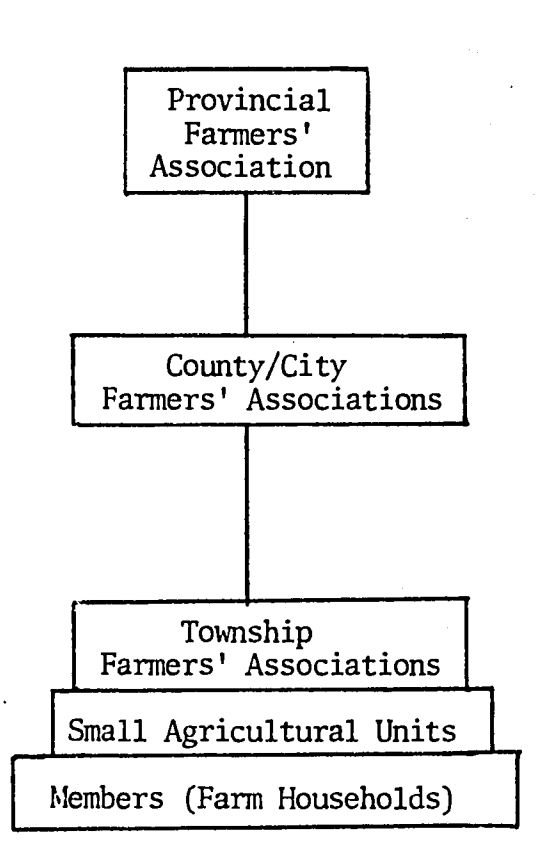



Figure 11: Levels of Organization of the Farmers' Associations in Taiwan

5. Postharvest Activities

A very high percentage of farmers in Taiwan are members of Farmers' Associations and approximately 20% of the total farm production is marketed through them. However, 90% of the rice production falls under the Food Bureau and is, thus, outside of the Farmers' Associations control. The cooperative marketing of hogs is one of the important activities undertaken by the association for its members. Cooperative marketing of fresh vegetables has become an important business and the supply of raw mushroom and asparagus for canning and export is handled solely by the Farmers' Associations under an integrated production and marketing program. Specialized associations such as TPFMC (see a,5, below) also are involved in the export of fresh fruits such as banana, citrus, and pineapple.

a. Physical Facilities

1) Assembling and dispersion: Of the 191 public markets in Taiwan, 73 are fruit and vegetable markets, 19 are livestock markets, and 99 are fish markets. Of the 73 fruit and vegetable markets, 17 are operated by local government, 29 by farmers' associations and 25 by farmers' associations, and local government combined.

2) Processing: The 274 Township Farmers' Associations maintain over 400 rice mills with a total milling capacity of 6,600 mt/day. They also have power tillers, soybean crushers, peanut hullers, sweet potato choppers, cotton gins, starch making machines, a chemical plant, feed plants and a packing plant.

3) Storage/warehousing: The Farmers' Associations have more than 2,500 warehouses with storage capacity in excess of 880,000 mt. These include warehouses for rice, fertilizer, and supplies.

4) Transportation: The Farmers' Associations own a number of trucks, jeeps and motor pedicabs.

5) Specialized handling: Taiwan Provincial Fruit Marketing Cooperative (TPFMC) owns and operates cold storage plants, and facilities for processing, auction, and grading/packaging in addition to one fruit cannery and a container factory for manufacturing cartons.

b. Trading Practices

The Farmers' Associations provide a marketing service by taking commodities such as paddy rice and other minor grains on a consignment basis. For hogs, vegetables, mushrooms, asparagus and some others they offer organized marketing by making an initial payment to farmer members upon receipt of product. After the product has been sold prices are pooled and a final adjusted payment is made to the farmer.

A contractual sales arrangement applies to many crops including vegetables. As a rule, the Farmers' Associations sign contracts with buyers and allocate quotas to farmer-members according to certain regulations and marketing plans.

c. Distribution of Farm Inputs

The Farmers' Associations distribute to their members farm production necessities, including improved seeds, fertilizers, farm chemicals, and farm implements.

d. Extension Service

The extension services provided by the township Farmers' Associations at the farm level include multiplication of improved seed varieties, breeding of improved livestock and poultry, disease control of livestock, farm demonstration, land preparation, transplanting, spraying of chemicals, and harvesting.

e. Credit

The township Farmers' Associations extend production (90%) and consumption (10%) loans to their members.

6. Considerations Related to Postharvest Losses

With an estimated 900,000 members, the PFA represents nearly 100% of the farm population. This organization is therefore a key element in any attempt to communicate improved food handling techniques to farmers.

## TAIWAN FRUIT AND VEGETABLE MARKETING CORPORATION (TFVMC)

1. General Objective

The TFVMC was established by executive order, proclaimed by Executive Yuan, on October 10, 1974. It began its operations on December 1, 1974. The TFVMC is charged with stablizing national fruit and vegetable prices and does so by engaging in wholesale activities through the Taipei Fruit and Vegetable Wholesale Market.

2. Specific Objectives

a. Adjust supplies and properly satisfy market demands
b. Simplify distribution channels and reduce intermediate costs to benefit both the producer and consumer
c. Stabilize prices to encourage production and to promote the farmers' interests
d. To provide service to both sellers and buyers on the basis of fair competition so as to prevent any possible monopoly.

3. Priority Commodities

There are approximately 80 vegetables and 40 fruits which are bought and sold at the Taipei Fruit and Vegetable Wholesale Market. Products such as cabbage, Chinese cabbage, bamboo shoots, Chinese radish, tomatoes, carrots, green onions, peppers, potatoes, sweet potatoes, and a few others are offered on a continuous basis throughout the calendar year while most of the remaining products are seasonal. At any one time more than 50 products are marketed.

4. Organizational Structure

The TFVMC is a quasi-public institution controlled by shareholders made up of Taipei Municipal Government, Provincial Government, farmers organizations, sellers, buyers, and employees of the market cooperation. They select a Board of Directors with 11 members representing government and 13 members reponsible for the supervision of the Business, Planning, Finance, Management, and Accounting Departments, as well as the Taipei Auction Hall. The organization chart for TFVMC is presented in Figure 12.

There are about 350 employyes in TFVMC, of which 160 work in the Auction Hall, 140 are office staff, and 50 work in the Supermarket. Nearly all are high school graduates and a high percentage are vocational school or university graduates.

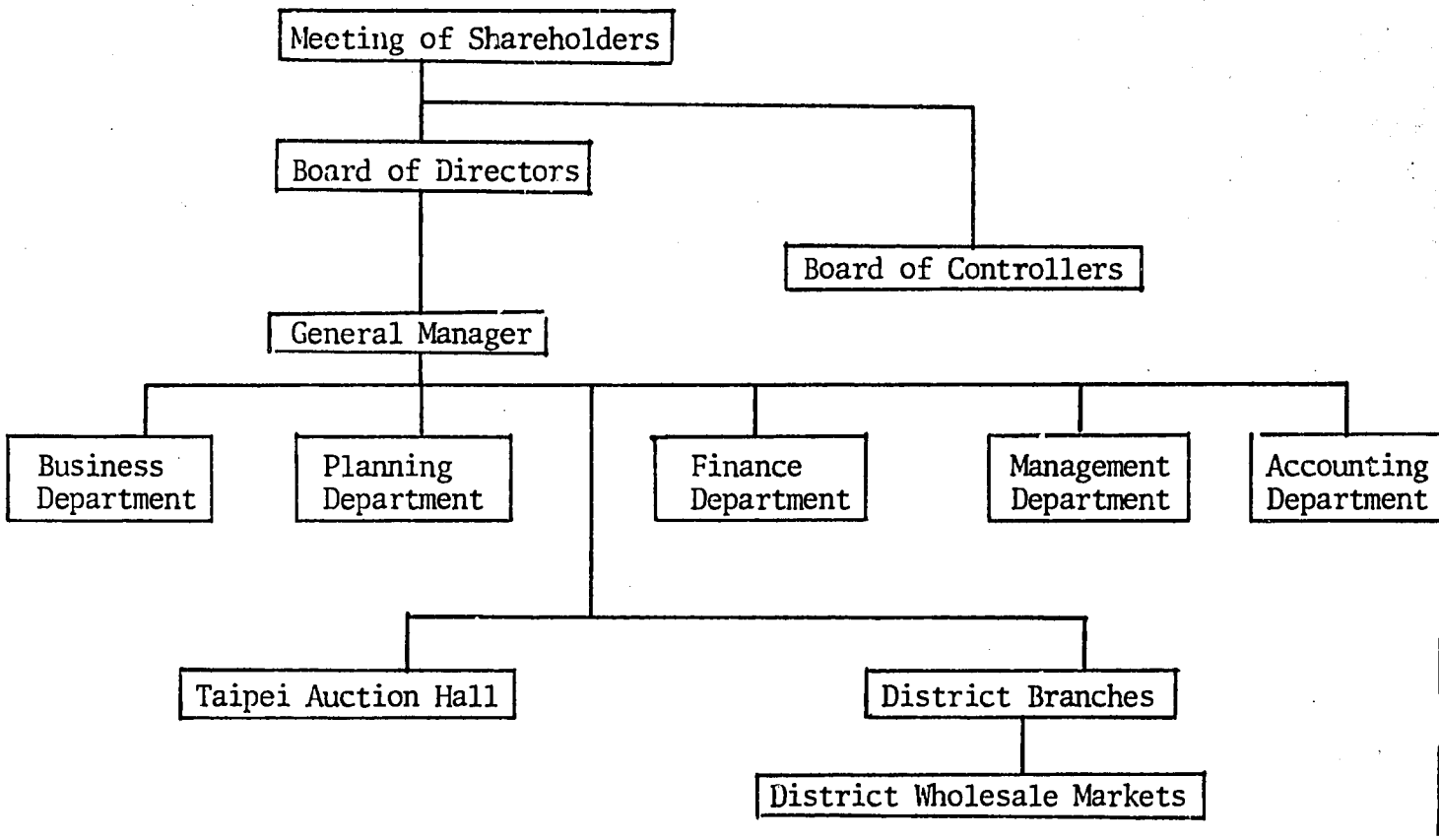



Figure 12: Organizational Structure of the Taiwan Fruit and Vegetable Marketing Corporation

5. Principal Postharvest Activities

To reach its objectives, TFVMC does planning, extension, and marketing activities.

a. Planning

The Taipei Fruit and Vegetable Wholesale Market is the principal source of price and volume of sales information on fruits and vegetables. Average daily price information and volume of sales are tabulated daily and made public the following day at 7:00 am and 12:00 noon. The radio and TV programs that transmit this price information are farmer oriented. This same price information is used as benchmark data for suggesting prices for the following day's auctions.

Since approximately 80% of fruit and vegetables consumed in Taipei flow through this Central Market, the TFVMC becomes an important source of information for planning supply and projecting demand. Each December TFVMC personnel meet with governmental planners to complete the planning operation which serves as the basis for many other agricultural sector development plans.

b. Extension

The TFVMC recognizes that one of its principal problems in the Wholesale Market is inadequate packing of vegetables received primarily from small and medium size farmers. Due to a wide variety of produce and relatively small volumes of each kind, it has been difficult to encourage growers to standardize the type of package material and size of package. To improve upon this situation, the Marketing Corporation promotes extension activities of two types:

1) On-farm visits by TRVMC technical staff to introduce new types of packages, banding, and stapling equipment and to instruct the farmers in their use

2) Organization of wholesale market tours for farmer associations and cooperatives to demonstrate the problems caused by improper packaging and how better grades of produce can translate into higher net returns to the farmer.

c. Marketing Activities

Because most TFVMC activities involve marketing, its principal functions are wholesale marketing, packaging, retail marketing, and storage. To accomplish these marketing functions, the Corporation owns considerable marketing infrastructure, including one retail supermarket, located in northern Taipei, and 54.6 ha of land in the south of Taipei containing the wholesale market facilities which are divided as follows:

| Use of Area | $M^2$ | % Total Area |
|---|---|---|
| Floor space of auction hall | 9,450 | 17.3 |
| Fruit wholesale distribution hall | 6,075 | 11.1 |
| Vegetable wholesale distribution hall | 6,600 | 12.1 |
| Cold storage space (ground) | 90 | 1.7 |
| (Total cold storage space) | (3,326) | |
| Administration building | 1,106 | 2.0 |
| (Total adm. bldg. space) | (3,663) | |
| Lavatories | 240 | 0.4 |
| Other 1/ | 30,282 | 55.4 |
| TOTAL AREA | 54,661 | 100.0 |

1/ Fish market, parking area, venicle streets underpass areas and miscellaneous

1) Wholesale Marketing

The wholesale operations begin as trucks arrive at the wholesale market and are weighed. Each seller/supplier purchases an information form prior to sale which identifies products with code number, number of cases, unit weight, and total weight. On the same form the market information recorder later fills out the type and number of cases received, the weight and grade (based on sample), and the type and number of cases not sold (after auction). Trucks then go to the unloading area where they are unloaded and the produce is inspected by market personnel to assure that information provided by the driver is correct. There are a maximum of 64 auctioneers at any one time - 41 for vegetables and 23 for fruits. The number varies season. The auctioneers wear dark blue caps, the information recorders orange, and the sellers light blue. The auctioneers (usually sons of farmers) are carefully selected for their knowledge of agricultural products and production areas. Attention is given to standardizing grading and pricing criteria among auctioneers to avoid price differences during auction.

Prior to the auction the auctioneer receives a sheet of paper bearing a table with recommended prices for each available commodity and grade. This table, prepared by a committee of three, is based on previous day's prices and product arrivals during the night (products begin arriving at 6:00 pm). The auctioneer then evaluates the products to be sold and fills out another form with lot number, supplier, commodity, grade and recommended prices (his opinion). If there is more than a 10% difference between the two recommended prices, a third party from the wholesale market evaluates the situation and determines the base price to begin the auction.

As the auction begins a group of 20-30 buyers makes a circle around the auctioneer; the first lot to be sold is identified; the seller opens one case and provides samples to buyers; information is given on number of cases, grade, weight and marketable index (an evaluation of the net weight after packaging and outside protective leaves are removed). Vegetable sales begin before fruit sales because fruits are less perishable and better packed.

Some small suppliers offer mixed lots of various products. In these cases the lot is selected, described and sold as one unit. After sale, stickers are glued to the containers and the products are sent to the cart people, normally women, who load and transport the products to the loading areas or out the gate, where they are controlled, and into the retail part of the market.

Once the sales are made, the auctioneers' forms are sent to the administrative office where the information is processed in computers to provide the financial data for receiving and making payments and for generating the base information (price and quantity) to initiate the following day's activities. The total auction process is normally completed within 3 hours (by 6:30 am). The buyers are registered with the Marketing Corporation and leave a deposit. They are given two days to cover their purchases. The Corporation makes payment to the sellers within three days and deposits directly into the sellers' accounts. The Corporation service charges of 3.2% is paid by buyer and seller in equal parts.

The containers used for the wholesale vegetable operation are cardboard boxes, square or round bamboo baskets, and to a lesser degree, polyethylene sacks. The capacity of the cardboard boxes is 20 or 30 kg while that of the baskets may reach 100 kg.

The marketing of fruits is more standardized and only cardboard boxes are used (20-30 kg). Fruit tends to be marketed in larger lots than are vegetables. Each box containing fruits or vegetables is marked with the same basic information, including seller's name, address, telephone number (perhaps village number) and association or bank account number. Also included are type of product, weight of box, grade (superior, good, normal, below normal) of product, and number of units inside. Daily sales by approximately 1000 sellers in total are on the order of 600-800 MT for fresh fruits.

Purchases are made in fairly small amounts and the total number of buyers on an average daily basis in excess of 1,000 (550 vegetables and 450 fruits). Total annual sales of vegetables during a 350-day work year can amount to between US$70 and $80 million.

2) Packaging and Retailing

Within the Central Market area the Marketing Corporation makes purchases through the auction process. The products obtained in this manner are retailed in small unpackaged amounts in the retail side of the Vegetable Distribution Hall (part of central market) or they are packaged in plastic for retail sales to supermarkets.

While relatively little repackaging is done in the wholesale market (Auction Hall), considerable repackaging is done in the Vegetable Distribution Hall where approximately 20-40% of the weight (outer leaves) of Chinese cabbage is removed. This "waste" is used for animal feed. Products such as bamboo shoots, cauliflower and many others lose significant proportions of their weight as they are made ready for the final consumer. Efforts are made to minimize losses by using ice on fresh leafy vegetables and to improve product appearance by washing Chinese radish, carrots, and others.

3) Storage

With its responsibility to guarantee food stocks over the summer months characterized by heavy rains (typhoons) the TFVMC is forced to store basic staples, such as onions, potatoes, carrots, cabbage, and Chinese cabbage. To accomplish this it uses two strategies:

a) Storing 2,800 MT of emergency supplies at its own and in rented space around the island

b) Contracting with farmers, at guaranteed prices, to supply very perishable food stuffs.

The cold storage facilities are operated by qualified technical personnel who are graduates of vocational schools and have received certificates in their areas of expertise. Although losses do occur in these facilities, inadequate trained staff is not the reason. The principal losses occur in those years in which the traditionally heavy rains do not occur. Under these circumstances summer production is maintained and the consumer is unwilling to purchase lower quality stored produce. These losses can be considered as the cost of insurance for guaranteed supply and have reached as high as US$100,000 in some years.

6. Considerations Related to Postharvest Losses

a. The TFVMC is both systems and service oriented. Market administrators are very much aware that product deterioration seen at the market end is a result of a series of causes occurring e -lier in the channel. They believe that the most important factors are inadequate rural packing facilities and farmers insufficiently trained in product handling. In their attempts to overcome these deficiencies they provide price information and training which is channeled through farmers' organizations.

b. The TFVMC has become the principal intermediary for fresh fruits and vegetables, handling 80% of these products sold in the Taipei area with an estimated value in excess of US$100,000,000 in 1982. The law requires that "all" fruits and vegetables pass through this market. Consequently, significant amounts of produce which otherwise might

possibly follow a more direct route to the consumer are forced to be sold at this Central Market. Moreover, unnecessary handling, transport and delays result in increased marketing costs and contribute to higher postharvest losses seen at the retail level. If TFVMC could attain its goal of price determination while handling a much smaller percentage of the total product, entrepreneurs could bypass the market, marketing costs might decrease, and smaller operators could depend on a fair market price.

c. Since approximately 40% of the volume handled by TFVMC comes from farmer associations and cooperatives, many unnecessary middlemen have been eliminated and higher returns are possible to farmers. Through farmers' associations, the TFVMC can be an important instrument in the transfer of information and new technologies to small organized farmers.

## D. MARKETING CHANNEL DIAGNOSIS

### 1. Vegetable and Fruit Production in Taiwan

Vegetable and fruit production has grown rapidly in Taiwan since the early Sixties. From 1962 to 1981 the area harvested in vegetables has increased 129%. Production has increased from 841,000 metric tons to 2,930,000 metric tons or 248 percent. Fruit area harvested increased by 217%. Production increased 264% from 471,000 metric tons to 1,717,000 metric tons during the same 20-year period.

Per capita consumption of fruits and vegetables has also increased significantly during the period of 1962 to 1981. Vegetable consumption per capita doubled from 57 kg to 115 kg and fruit consumption quadrupled from 20 kg per capita to 81 kg per capita.

Along with the growth in production and consumption of fruits and vegetables in Taiwan, the export of processed and fresh vegetables and fruit has increased. These exports include canned asparagus, canned mushrooms, fresh vegetables, canned bamboo shoots, citrus, bananas, fresh and canned pineapple, and other items including Chinese cabbage and fresh and processed tomatoes. The value of fruit and vegetable exports rose from US $28.8 million to US $632.7 million between 1962 and 1981. Japan, Hong Kong and Singapore are the major markets for fresh fruits and vegetables, while processed exports are shipped primarily to the U.S., Japan and West Germany.

### 2. Selection of Commodities Subject to Case Studies

Tomatoes were selected for investigation in this postharvest study because of their economic importance, coupled with the consideration that their handling and storage characteristics are shared by many perishable fruits, and both tomatoes and Chinese cabbage are crops with which AVRDC has considerable experience.

Agricultural researchers and government planners in the subtropical and tropical countries are interested in tomatoes because of their high yield and income potential to small producers with extensive labor available. It has been estimated in Taiwan that tomato production requires 2,180 labor hours per hectare for the processing variety and 8,020 labor hours per hectare for the fresh variety. (7)

In addition to fresh market varieties offering a high return per unit of land and the opportunity to use surplus family labor in the production process, these varieties have the added appeal of providing a continuous cash income for several months and are adaptable to small farm operations near urban areas or markets.

Processing tomato varieties offer the advantage of being adaptable to areas relatively far from markets and suitable to rotation systems with rice or upland crops. They also provide additional employment opportunities and offer another processing line in conjunction with products such as pineapple, mushroom, and canned asparagus for the canned food industry in a year-around factory operation.

Fresh and processed tomato products have also successfully penetrated export markets, and thus increase the value of foreign exchange earned. The quantity and value of tomatoes and tomato products exported by Taiwan from 1973 to 1981 and the destination of these exports in 1981 are presented in Appendix I. Tomatoes contributed over US $30 million to Taiwan's foreign exchange earnings in 1981, compared to less than 2 million in 1973.

Chinese cabbage was selected as the other case commodity in Taiwan because it is one of the most perishable commodities. It represents the leafy vegetables, and it is widely produced throughout the rest of Asia, as well as in Taiwan. A survey of consumers in Taiwan showed that it is popular because of its taste and appearance.

Tomato and Chinese cabbage are sources of several nutrients. A table presenting the nutrient contents of these and four other vegetables reported by the Asian Vegetable Research and Development Center is included in Appendix II. Tomato and Chinese cabbage marketing is subject to the extreme variability in volumes of marketing and in prices (see Figures 13 & 14). This price volatility accentuates the postharvest problems of marketing these vegetables. Preharvest actions and improvement in storage might offer potential to ameliorate these fluctuations.

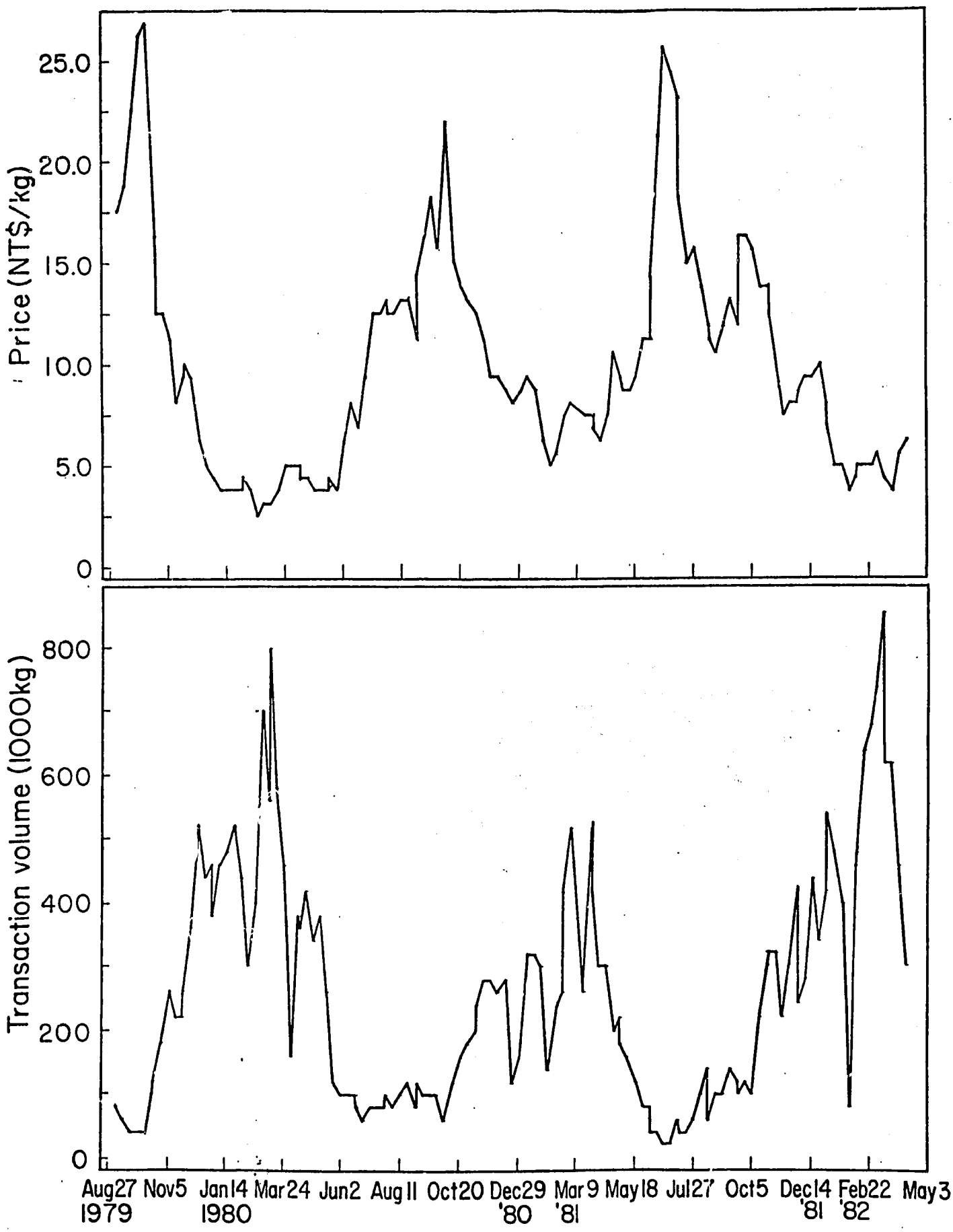



Fig. 13 Weekly average tomato price and volume in Taipei wholesale market 1979-82

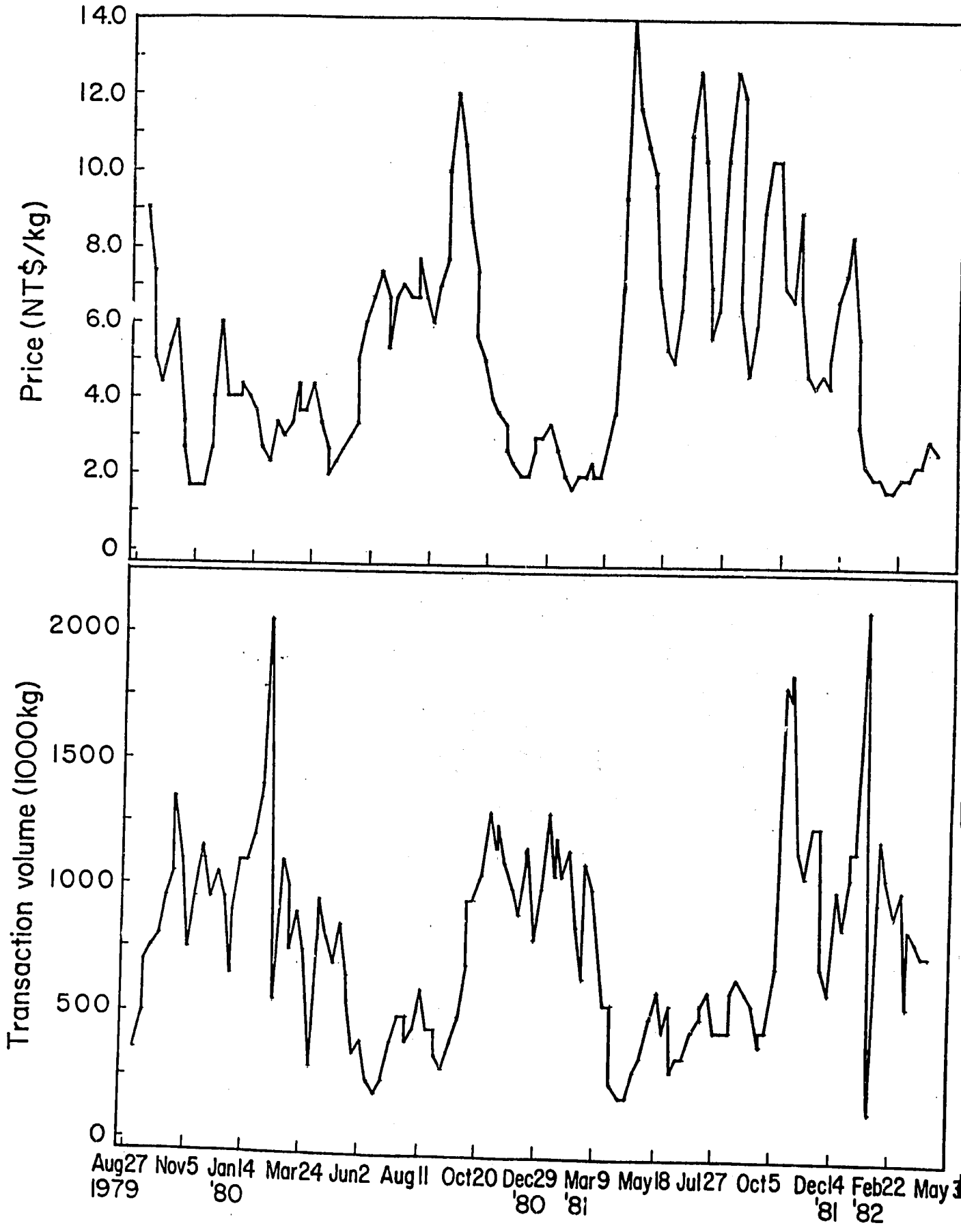



Fig. 14 Weekly average Chinese cabbage price & volume in Taipei wholesale market, 1979-82

3. Marketing Channels for Vegetables and Fruit

Figure 15 shows the alternative channels that are most frequently used for marketing vegetables and fruit in Taiwan and identifies the principal participants.

a. Rural buyers: These intermediaries are located near the production areas and provide an assembly function. They purchase produce from as many as several hundred farmers, paying prices based on morning radio price information broadcasts. They select, grade, pack, and ship produce to wholesalers and retailers.

b. Farmers' associations: These organizations provide a series of marketing services including infrastructure for storing, selling, processing and transportation. They coordinate cooperative production (quota system) and marketing. Decision making and services are frequently untimely.

c. Jobbers: These agents receive consignments from producers or shippers in rural areas and sell to wholesalers and retailers on a commission basis.

d. Public Wholesale Market: Public facilities (cement floor and metal roof with ample parking area) are often operated by Farmers' Associations. Buyer meets sellers and sales are made by direct negotiation or by auction.

e. Wholesalers: These merchants receive shipments from producers, rural buyers, farmers' associations, jobbers or other shippers and distribute to retail merchants, secondary wholesalers, processors, or exporters. Wholesalers undertake the function of assembly and may also engage in grading, packing, and simple processing.

f. Retailers: As the last link before the consumer, retailers operate retail stands in public markets as well as in supermarkets.

g. Processors: Normally equipped with packing and processing facilities, processors tend to change the form of the commodity by canning, freezing, or dehydrating.

h. Exporters: These receive produce from the producers, wholesalers or farmers' organizations. They may select, grade, package, cool, store, and transport the product themselves at the port facilities or they may simply give instructions to producers or wholesalers who will prepare and deliver the commodities to the port.

4. A Postharvest Technological Approach to Looking at Marketing Channels

Figure 15 is useful in providing a general understanding of the marketing system and in identifying participants and ports in the channel which should be the focus of additional attention. Identifying where food losses occur and what their causes are requires more detailed studies on what happens to the produce at or between those points shown in Figure 15; for example, between produce and rural buyer or at the wholesale market, etc. In the following analysis a postharvest technological approach is used in looking at the market channels for Chinese cabbage and salad tomatoes.

Table 2 summarizes a study of the postharvest system for Chinese cabbage in Taiwan during the month of September 1983. Some important observations related to this data follow.

The extreme care taken by the Taiwanese farmer in harvest and in field handling of Chinese cabbage implies an economic incentive to keep postharvest losses to a minimum. The farmer shows an understanding of the physiology of the plants, as demonstrated by harvesting the product for export in the afternoon when water content is minimal. He also demonstrates economic awareness by harvesting products for local consumption in the mornings when product water content, and hence weight, is at a maximum. Products with higher moisture content tend to deteriorate faster and shrinkage is greater; thus this practice of early morning harvesting for local consumption places an additional burden on wholesalers and retailers who often find themselves holding containers of produce weighing 3-10% less then the amount originally sent to market by the farmer. When intermediaries complain to the producers of this problem, they are often compensated on the following purchase.

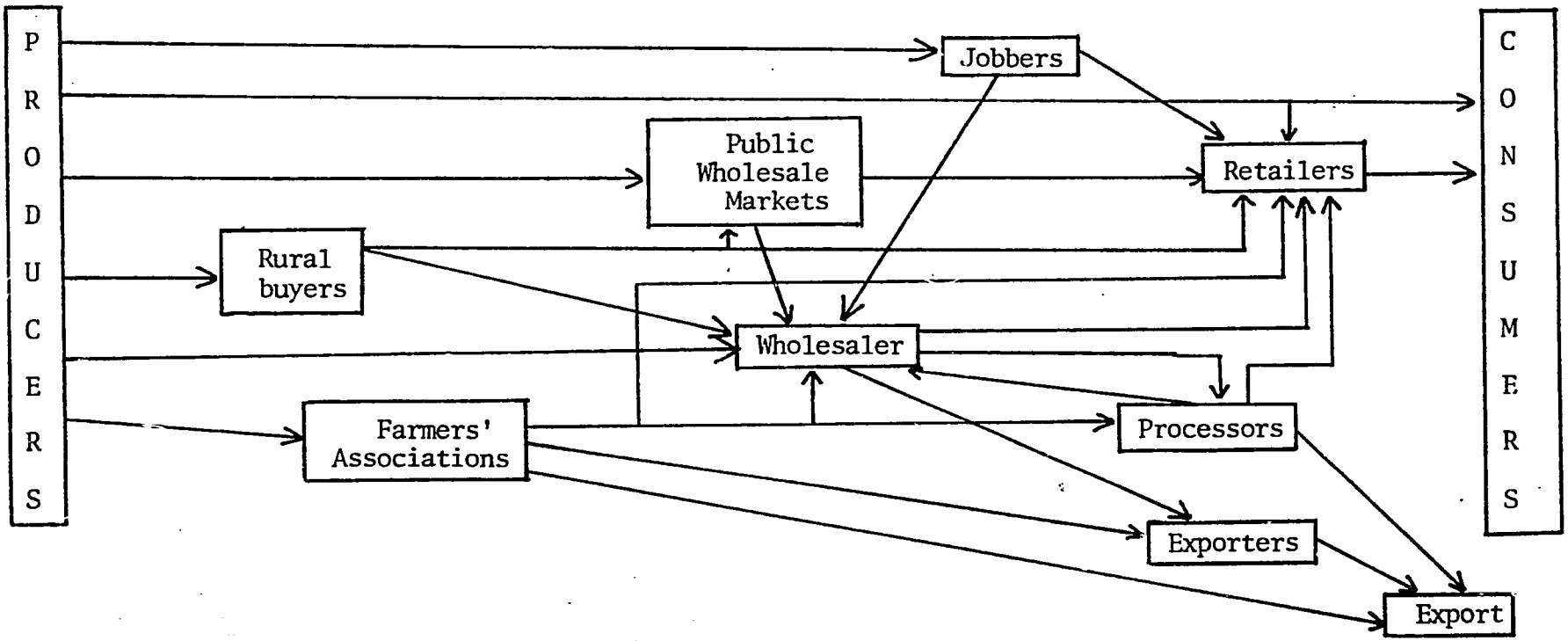



Figure 15: Alternative Marketing Channels for Vegetables and Fruit

The method of piling the produce, from which the outside protective leaves have been removed, on the leaves themselves rather than on the ground demonstrates the farmers understanding of the importance of maintaining produce cleanliness and quality.

On-farm packing seems to be done with efficiency and care and is oriented towards minimizing the opportunity for bruising the products. The produce packed in baskets and on trucks are laid horizontally so that hard centers do not damage neighboring pieces. Cabbage bound for export is left with its protective leaves attached until ready for packing in cardboard boxes at assembly centers.

Since produce is transported between production areas and central markets in late evening and at night over a road system that is in excellent condition, transportation is probably not a major factor in causing losses. Even if it were, the alternatives for reducing such losses would be extremely costly, e.g., refrigerated trucks.

Losses seem extremely high at the wholesaler or retailer level, depending upon who removes the outer leaves. The losses caused throughout the whole system tend to accumulate and are disposed of at this point. However, a high percentage of what appears to be loss is related to the outer leaves which do not constitute significant loss if they are considered packaging material.

As soon as produce is packed for export it is placed in cold storage at $0^{o}C$ to remove field heat and is later transferred to refrigerated trailers on the first leg of the voyage to the Hong Kong or Singapore markets.

The postharvest system for handling salad tomatoes (Table 3) is also a very efficient one. During harvest an attempt is made to keep family members involved, partially to minimize damage to the product. Qualified hired labor may be used to grade and pack. The packers make an effort to put the nicest fruit on top but all normallys meet minimum standards.

The product is in the hands of the retailer, and often the consumer, within 24 hours of harvest. Therefore, after it is packed in the cardboard container, sealed and banded, little significant loss occurs, unless the truck is delayed for some reason.

During the period of this study tomato production was low, prices were high, and a great deal of attention was given to maintaining quality. It is most likely that during the winter harvest this situation is distinct; production is high, labor is scarce and only the highest quality fruit is packaged for market.

The Pre-Packing Alternative No. 1 (Table 3), where produce is packed at the farm in bamboo crates holding 100 kg or more and transportation is on the back of motorcycles, through fields and on trails, probably yields the highest level of losses. It is very possible that the quantification of losses during the winter season (January - March) would reveal the highest level of loss at any point in the system. However, it is unlikely that these losses could be reducible in economic terms.

Table 2 Analysis of the Post Harvest System for Chinese Cabbage in Taiwan, September 1983.

| Type Information Desired | Point in HARVEST | In field ASSEMBLY | On Farm PACKING | On Farm TRANSPORT |
|---|---|---|---|---|
| WHO is responsible for activity? | - Farmer<br>- Family members<br>- Hired labor | same as harvest | Some of those doing harvest and assembly | Family members or hired labor |
| What action is taken? | Product separated from plant with knife | Product grouped in piles to facilitate packing | Product placed in bamboo baskets and/or loaded on truck | Product taken from field to means of motorized transport |
| HOW is action done? | Local Sales:<br>All or some green leaves may be removed<br>Export Sales:<br>Green leaves are left on head | Local Sales:<br>Piled on green leaves at edge of field if all green leaves have been removed<br>Export Sales:<br>Piled in field on ground | Local Sales:<br>Placed in bamboo baskets in circular manner horizontally; succeeding layers packed tightly to fill in spaces<br>Export Sales:<br>Taken loosely to truck where stacked pyramid fashion (1,000-2,000 kg) individually | Local Sales:<br>2 men carry basket(60-80 kg) on pole to truck where it is loaded.<br>Export Sales:<br>Same as above, except at truck product removed from basket and stacked on truck |
| WHEN is action done? | Local Sales:<br>Morning<br>Export Sales:<br>Afternoon | Same as for harvest | Same as for harvest | Same as for harvest |
| WHY is action done? | To maximize returns:<br>Local Sales:<br>Increase weight of product<br>Export Sales:<br>To reduce % of water and thus potential postharvest loss | To facilitate packing in baskets | Local Sales:<br>To minimize damage to product<br>Export Sales:<br>To allow larger numbers to be carried on truck with minimal damage | To minimize labor requirements |
| WHERE is action done? | Small Farms | Small Farms | Small Farms | Small Farms |

| Marketing Channel | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| To Market TRANSPORT | UNLOAD at Market | PACKING for export | COOLING for export | PACKING for local market | TRANSPORT to Central Market | AUCTION Sale | PREPARATION for retail | SALE to Consumer |
| Farmer or sons | Farmer or buyer hired laborers | Exporter hires labor | Exporter at coop facilities | Wholesaler retailer processors | Wholesaler | Taiwan Fruit & Vegetable Marketing Corporation | Retailer or helper | Retailer |
| Product taken from farm to market | Product taken from truck and placed on ground | Product placed in cardboard boxes | Product stored in refrigerated rooms | Product repacked in low cost baskets | Baskets taken to Central Market | Product in box or crate is received, evaluated and sold at auction | Outside leaves are removed | Product sold to consumer |
| Local Sales: Farmers or rented truck takes product to market where truck is weighed with and w/o product Export Sales: Same but truck not weighed | Local Sales: Product taken from farmers basket and placed in less expensive basket Export Sales: Product emptied on ground for leaf removal and repacking | Outside leaves are removed and product is placed in cardboard box with 20 kg. capacity | Cardboard boxes are placed in cold storage held at 0°C | Product removed from large farmer (60-80 kg) baskets and repacked in smaller one-way bamboo baskets. Additional leaves removed if necessary | Wholesalers or retailers or processors transport baskets to central market, retail market or processing facilities normally using their own transportation | Auctioneer receives product, samples, classifies and determines base price. Samples are shown buyers who bid on product | Leaves are bent or pulled off and stem is trimmed with knife | Consumer asks price, seller states price per 600 gms(catty), buyer can take it or leave it. Product is weighed |
| Same as for harvest | Same as for harvest | Same as for harvest | Same as for harvest | Same as for harvest | Afternoon and/or evening | Between 3:30-6:30 am | 5:30-8:30 am | 6:00 am - 12:00 noon to a lesser degree 12:00 - 18:00 |
| Necessary due to long distances to assembly centers (markets) | Product changes ownership | To meet consumer demand for quality | Remove field heat and minimize losses | Economize on type package used as farmers baskets more expensive | To reach final market in urban area | To transfer ownership from wholesaler and farmer associations to other wholesalers | To improve appearance for final consumer | To exchange ownership |
| Rural areas | Rural/Urban Markets | Rural/Urban Markets | Cooperative Urban Markets | Rural/Urban Markets | Rural to Urban Markets | Taipei Central Market | Retail outlet | Retail outlet or market |

Table 3. Analysis of the PostHarvest System for Salad Tomatoes in Taiwan, September, 1983

| Type Information Desired | HARVEST | ASSEMBLY edge of field | PRE-PACKING Alternative #1 |
|---|---|---|---|
| WHO is responsible for activity? | Wives<br>Daughters<br>Hired labor | Family members | Family members |
| WHAT action is taken? | Tomato is twisted and separated from stem and placed in plastic container | Produce carried to edge of field and dumped in pile | Produce graded and packed in bamboo crates 100 kg capacity |
| HOW action is done? | Export tomatoes are picked at mature green stage while those for local sales are picked half red-half green. Unmarketable produce is left infield | If price of produce is high it is treated with loving care | Produce is placed loosely in crates which are loaded on motorcycles for transport to wholesaler |
| WHEN action is done? | 7:00 -11:00 am | Immediately after harvest | After harvest completed |
| WHY action is done? | Produce is at optimum point for marketing | To assembly produce at one point for grading and packing | To eliminate non-marketable produce and prepare for sale to wholesaler |
| WHEN action is done? | Summer: high lands<br>Winter: low lands | In shaded area, edge of field | Shaded area edge of field |

| TRANSPORT Farm-wholesaler | Point in PACKING Alternative #2 | Marketing Channel PACKING Alternative #3 | PACKING Alternative #4 | TRANSPORT -Taipei -Kaoshiung | EXPORT | AUCTION Sale | Wholesale Retail sales |
|---|---|---|---|---|---|---|---|
| Farmer | Middleman wholesaler | Family members hired labor | Family members or wholesalers and/or hired labor | Normally hired transport | Exporter | Taipei Fruit & Vegetable Marketing Corporation | Wholesalers Retailers |
| Produce in bamboo crates transported from farm to wholesaler | Wholesaler receives produce from hundreds of farmers; grades, packs, ships to Taipei | Produce graded, sorted, stems are cut and then placed in 20 kg cardboard boxes (best fruit on top) and sealed | Produced graded for export and packed | Produce loaded on trucks and sent straight to Kaoshiung for export or Taipei wholesale market | Product loaded into refrigerated trailer | Product in box or crate is received, evaluated and sold at auction | Transports product from Central Market to retail outlet where product sold to consumer |
| Motorcycles when small amounts, larger crates by three wheelers | Receives Taipei market price by radio at 7:00; purchases lot from farmers; grades by size, color, quality; packs in cardboard boxes | Tomatoes grouped by size, color, quality; stems cut; same grade packed in box in 5 layers separated by newspaper with rice husks on bottom; box weighed and sealed with plastic band or staple | Only top quality produce at mature green stage is selected. Stems are cut and produce is well packed in wooden 30 kg flats | Produce stacked 5 boxes high covered with plastic if rain expected | Hired labor unloading and loading | Auctioneer receives product, samples, classifies and determines base price. Samples are shown buyers who bid on product | Wholesaler transports, retailer unpacks, grades and packages for retail |
| Normally before noon | Receives by 11:00, packs afternoon, ships evening | Afternoon hours | Afternoon hours | Late afternoon, evenings | Night | Between 3:30 - 6:30 am | Early morning |
| Rapid low cost transportation | To obtain large volume and prepare quality product to meet market standards | Standards set by Central Market Taipei and Farmers Association. Farmer attempts to maximize returns. Culls sold to restaurants for frying. | To assure the best quality produce for shipment to HongKong | Transport between production and consumption center | Remove field heat as soon as possible | To transfer ownership from wholesaler and farmer associations to other wholesaler | Change of ownership |
| Between farm and some of rural wholesaler | Home of wholesaler in small shed | Usually farmers home; shed or living room | Usually farmers home or nearby assembly point | Rural to urban | Port of Kaoshiung | Taipei Central Market | Large cities at retail outlets |

## E. ELEMENTS OF A NATIONAL STRATEGY TO CONTROL POSTHARVEST FOOD LOSSES

## F. AVRDC/PIP SUPPORT ACTIVITIES

Sections E and F above cannot be completed at this time because they both require consultations with national decision makers at a later date.

APPENDIX I

EXPORTS OF TOMATOES AND THEIR PREPARATIONS

| Item | 1973 | | 1975 | | 1977 | | 1978 | | 1979 | | 1980 | | 1981 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Quantity | Value | Quantity | Value | Quantity | Value | Quantity | Value | Quantity | Value | Quantity | Value | Quantity | Value |
| Total | 11,014 | 1,946 | 22,535 | 9,782 | 37,023 | 15,492 | 52,803 | 25,861 | 50,944 | 27,834 | 62,522 | 37,020 | 53,932 | 31,733.1 |
| Fresh | 6,089 | 308 | 4,264 | 263 | 6,305 | 717 | 6,509 | 845 | 4,462 | 485 | 3,102 | 376 | 3,490 | 527.2 |
| Paste | 3,310 | 1,128 | 14,975 | 7,744 | 14,036 | 6,992 | 35,847 | 20,842 | 37,383 | 23,251 | 47,149 | 30,785 | 39,748 | 26,110.4 |
| Juice | 541 | 162 | 328 | 162 | 6,153 | 2,685 | 2,717 | 1,346 | 2,772 | 1,530 | 3,342 | 1,842 | 1,876 | 960.0 |
| Preserved in temporary Preservatives | 3 | 0 | 33 | 12 | 5 | 1 | 107 | 130 | 48 | 63 | 0 | 0 | - | - |
| Ketchup | 1,071 | 348 | 2,935 | 1,601 | 10,524 | 5,097 | 885 | 415 | 885 | 442 | 875 | 484 | 1,027 | 642.6 |
| Canned | - | - | - | - | - | - | 6,738 | 2,283 | 5,394 | 2,063 | 8,054 | 3,533 | 7,791 | 3,492.9 |

Source: Agricultural Trade Statistics of Taiwan, 1982.

Quantity: M.T.
Unit[Value: US$1,000

APPENDIX I, continued

EXPORTS OF TOMATOES AND THEIR PREPARATIONS IN 1981 -BY DESTINATIONS

| Country | Fresh | | Paste | | Juice | | Ketchup | | Canned | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Quantity | Value | Quantity | Value | Quantity | Value | Quantity | Value | Quantity | Value | Quantity | Value |
| Total | 3,490 | 527.2 | 39,748 | 26,110.4 | 1,876 | 960.0 | 1,027 | 642.6 | 7,791 | 3,492.9 | 53,932 | 31,733.1 |
| Japan | - | - | 24,294 | 16,078.7 | - | - | 314 | 199.3 | 3,198 | 1,331.9 | 27,806 | 17,609.9 |
| U.S.A. | - | - | 5,639 | 3,546.4 | - | - | 20 | 13.3 | 346 | 116.2 | 6,005 | 3,675.9 |
| Hong Kong | 3,421 | 499.3 | 53 | 36.9 | - | - | 228 | 127.7 | 31 | 15.5 | 3,733 | 679.4 |
| Korea, Republic of | 47 | 19.1 | 2,297 | 1,564.3 | 0 | 0.1 | 10 | 3.9 | 0 | 0.3 | 2,354 | 1,587.7 |
| Singapore | 22 | 8.8 | 522 | 334.8 | - | - | 379 | 258.2 | 62 | 34.5 | 985 | 636.3 |
| Philippines | - | - | 3,195 | 2,124.1 | - | - | - | - | - | - | 3,195 | 2,124.1 |
| Thailand | - | - | 823 | 573.1 | - | - | - | - | - | - | 823 | 573.1 |
| Saudi Arabia | - | - | 368 | 258.9 | 720 | 391.7 | 51 | 23.6 | 3,037 | 1,440.6 | 4,176 | 2,114.8 |
| Other countries | - | - | 2,557 | 1,593.2 | 1,156 | 568.2 | 25 | 16.6 | 1,117 | 553.9 | 4,855 | 2,731.9 |

Source: Agricultural Trade Statistics of Taiwan, 1982.

Quantity: M.T.
Unit[Value: US$1,000

# APPENDIX II

Comparative nutrient contents per 100 gm portions of selected foods; AVRDC, 1978.

| Nutrient | Chinese cabbage | Common cabbage | Tomato | Mungbean sprouts | Soybean milk | Sweet potato |
|---|---|---|---|---|---|---|
| Calories | 11 | 15 | 14 | 15 | 42 | 77 |
| Protein (gm) | 0.7 | 1.3 | 1.1 | 1.8 | 3.6 | 0.7 |
| Calcium (mg) | 16.0 | 34.0 | 4.0 | 11.0 | 15.0 | 11.0 |
| Iron (mg) | 1.3 | 4.3 | 1.6 | 0.5 | 1.2 | 1.8 |
| Vit. A (I.U.) | 105.0 | 134.0 | 617.0 | Tr. | n.a. | 21,130.0 |
| Thiamine (mg) | 0.04 | 0.01 | 0.04 | 0.08 | 0.03 | 0.03 |
| Riboflavin (mg) | 0.03 | Tr. | 0.03 | 0.10 | 0.02 | 0.07 |
| Niacin (mg) | 0.22 | 0.35 | 0.53 | 0.10 | 0.50 | 1.24 |
| Vit. C (mg) | 18.0 | 22.0 | 15.0 | 19.0 | n.a. | 31.0 |

Source: Peter H. Calkins, Vegetable Consumption Patterns in Five Cities of Taiwan, Asian Vegetable Research and Development Center Technical Bulletin #5 (78-94), September 1978.

SELECTED BIBLIOGRAPHY

1. Amezquita, Rafael and Jerry La Gra. "A Methodological Approach to Identifying and Reducing Postharvest Food Losses", Santo Domingo, In American Institute of Agricultural Services Office in the Dominican Republic Miscellaneous Publication No. 219. (December, 1979).

2. ASPAC Food Fertilizer Technology Center, et al. "Proceedings of Workshops on Handling and Storage of Crops after Harvest." Hsinchu, Taiwan, (June 19-25, 1977).

3. AVRDC. "Pre and PostHarvest Vegetable Technology in Asia." Asian Vegetable Research and Development Center, Shanhua, Tainan, Taiwan. (Sept., 1977).

4. Bressani, Richardo. "World Needs for Improved Nutrition and the Role of Vegetables and Legumes." Shanhua, Taiwan, Asian Vegetable Research and Development Center, 10th Anniversary Monograph Series, (1983).

5. Calkins, Peter H. "Improving Marketing of Perishable Commodities: A Cost study of Selected Vegetables in Taiwan." Asian Vegetable Research and Development Center Technical Bulletin No.9 (78-86), (February, 1980).

6. Calkins, Peter H. "Vegetable Consumption Patterns in Five Cities of Taiwan." Asian Vegetable Research and Development Center, Technical Bulletin No. 5 (78-94), (Sept., 1978).

7. Calkins, Peter H. "Improving Small Scale Tomato Production in the Tropics." First International Symposium on Tropical Tomato. AVRDC Publication 78-59.

8. Chang, W.N. and A.Y. Su. "Some Onion Cultivars and Effects of Temperatures on Bulb Storability". Dept. of Horticulture, National Chung Hsing University, NCHU Horticulture, (June, 1981).

9. Chang W.N. and F.Y Kuo. "Effects of Nitrogen on Plant Growth and Bulb Quality of Onion, Allium cepa." Dept. of Horticulture, National Chung Hsing University, NCHU Horticulture No. 7 (June, 1982).

10. Chen, Hsing-yiu. "The Marketing of Fruit and Vegetables in Taiwan." In The Marketing of Farm Products in Taiwan and Korea. Food and Fertilizer Technology Center Extension Bulletin No. 193, (July, 1983).

11. Chen, Ru-yin, Jui-sen Yang and Lii-kuen Keu. "Bulb Storage of Cabbage and Chinese Cabbage at Low Temperature." Food Industry Research and Development Institute, Research Report No. 268. (November, 1982).

12. Chien, M.S., J.S. Yang and M.L. Liao. "The Function of CMC (Sodium Carboxymethyl Cellulose) When Used for Fruit and Vegetable Storage." Food Industry Research and Development Institute, Research Report No. E-30. (Nov. 1981).

13. Dept. of Agriculture and Forestry. Taiwan Provincial Government, Taiwan Agricultural Yearbook. 1983 Edition.

14. Dept. of Agriculture and Forestry, Taiwan Agricultural Products Wholesale Market Yearbook. 1982 Edition.

15. Dept. of Farmers Service, Council for Agricultural Planning and Development. Agricultural Trade Statistics of Taiwan, R.O.C. Taipei, Taiwan. (September, 1982).

16. Harris, Kenton L. and Carl J. Lindblad. Postharvest Grain Loss Assessment Methods. American Association of Cereal Chemists, 1978.

17. Horng, D.T. and C.H. Peng. "Studies on Package, Transportation and Storage of Waxapple Fruits (Syzygium samarangense)." Dept. of Horticulture, National Chung Hsing University, NCHU Horticulture No. 8 (June, 1983).

18. Hsu, Wen-Fu. "An Economic Analysis of Marketing Loss of Fruits and Vegetables in Taiwan." in: Some Studies of Fresh Fruit and Vegetable Marketing in Asia (ed, by H. Southworth). New York: The Agricultural Development Council, 1974.

19. Liang, Jong-Lung. "A Study on Machines for Making Rice-Husk Charcoal." Journal of Chinese Agricultural Engineering Vol 20, No. 3 (Sept. 1, 1974).

20. Liao, Ming-long, Ming-sai Liu and Jui-Sen Yang. "Respiration Measure of Some Fruits and Vegetables of Taiwan (II)." Food Industry Research and Development Institute Research Report No. E-66 (July 1982).

21. Lee, Shu-Ching. "Cost Analysis of Passion Fruit Juice and Its Potential in Commercialization." Food Industry Research and Development Institute Research Report No. 263 (October, 1982).

22. Lee, Tan-cha and Yeong-biou Yu. "Postharvest Control of Green Mold Rot on 'Ponkan' Oranges by Carbon Monoxide." Journal of the Chinese Society for Horticultural Science, Vol. 29, No. 2 (June, 1983).

23. Leu, Lii-Kuen, Gerald J. Chen and Tin-Yin Liu. "Economic Evaluation of Bulk and Bag Storage of Paddy Rice." Food Industry Research and Development Institute, Research Report No. E-28 (November, 1981).

24. Li, Gwo-chen. "Residue and Toxicity Problems Associated with Pesticide Use in Taiwan." Reprinted from Tropical Agricultural Research Science No. 16. Tropical Agricultural Research Center, Ministry of Agriculture Forestry and Fisheries, Yatabe, Japan, (January, 1983).

25. Lin, Shue-cheng. "Studies on Keeping Quality of Vegetable and Fruit by Controlling Atmosphere in a Permeable Film Package." Journal of Taiwan Agricultural Research, Vol. 23, No. 1 (March, 1974).

26. Lin, Shue-cheng. "Studies on Fruit Ripening. 1. Comparisons of Ripening Parameters, Peroxidase Activity, and Peroxidase Zymograme of Normal and rin Mutant Tomatoes." Jour. Agric. Res. China, Vol 28, No. 2 (1979).

27. Lin, Shue-cheng and Hui-ling Chiang. "Studies on Transit and Storage methods of Lychees." Jour. Agric. Res. China, Vol. 30, No. 3, (1981).

28. Lin, Shue-cheng and Mong-yu Yen. "The Effect of Several Chemicals and Fungicidal Waxes on Decay Control in Loose-skinned Oranges." Journal of The Horticultural Society of China, Vol. 17, No. 2, (March, 1971).

29. Lin, Shue-cheng, Wei-yee Wang and Yu-yiang Tsong. "A comparison of Fruit Qualities and Storability on Domestic Grown and Imported Apples." Journal of Agriculture Research of China, Vol. 30, No. 4 (December, 1982).

30. Lin, Shue-cheng, Wei-yee Wang, Hui-ling Chiang and Fu-wen Liu. "Long-term Storage of Cabbage and Chinese Cabbage." Jour. Agric. Res. China, Vol. 30, No. 4 (1981).

31. Lin, Shue-cheng and Wei-yee Wang. "Effect of Harvesting Date, Storage Temperature, and Packaging Material on The Decay and Quality of Orange (Citrus Sinesis, Var. Golden-seal)." Journal of Agricultural Research of China, Vol. 31, No. 1 (December 1982).

32. Liu, Ming-Sai, Ming-Long Liao and Jui-sen Yang. "Respiration Measurements of Some Fruits and Vegetables of Taiwan." Food Industry Research and Development Institute Research Report No. E-25. (December, 1981).

33. Liu, M.S. and Paul C. Ma. "Postharvest Problems of Vegetables and Fruits in the Tropics and Subtropics." Asian Vegetable Research and Development Center 10th Anniversary Monograph Series, 1983.

34. National Research Council Board of Science and Technology for International Development. "Postharvest Food Losses in Developing Countries." National Academy of Sciences, Washington, D.C. 1978.

35. Su, A.Y. and W.N. Chang. "Effects of $GA^3$, ABA and MH-30 on Storability of Onions." Dept. of Horticulture, National Chung Hsing University, NCHU Horticulture No. 5, (June, 1980).

36. Tai Chee-chen, Khiet-Hoa Li, Meei-shin Guo, Chin-fung Li, Rou-su Chao and Ssu-chung Chen. "Storage of Milled Rice in Plastic Bags Flushed with $CO_2$ or in Vacuum." Food Industry Research and Development Institute, Research Report No. E-18 (November 1981).

37. Yang J.S., M.L. Liao and M.S. Liu. "Packaging and Transportation of Papaya and Mango in Taiwan R.O.C." Food Industry Research and Development Institute Research Report No. E-17 (December, 1981).

38. Yang, Jui-sen, Tsung-chain Chang, Ming-sai Chien, and Tin Yin Liu. "Studies on the Post-Harvest Handling and Storage of Peapods, Stringbeans and Edible Budocks." Food Industry Research and Development Institute Research Report No. 136 (January, 1979).

39. Yu, Yeong-biau. "Ethylene Biosynthesis and its Regulation in Plant Tissues." Journal of Chinese Society for Horticultural Science, Vol. 27, No. 2 , 3 (May, 1981).