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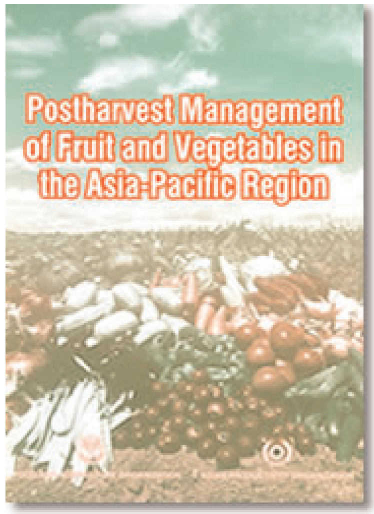
Postharvest Management of Fruit and Vegetables in the Asia-Pacific Region



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Reports of the APO seminar on Reduction of Postharvest Losses of Fruit and Vegetables held in India, 5–11 October 2004
and
Marketing and Food Safety: Challenges in Postharvest Management of Agricultural/ Horticultural Products in Islamic Republic of Iran, 23–28 July 2005

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Postharvest Management of Fruit and Vegetables in the Asia-Pacific Region

FOOD AND AGRICULTURE ORGANIZATION

ASIAN PRODUCTIVITY ORGANIZATION

Reports of the APO seminar on Reduction of Postharvest Losses of Fruit and Vegetables held in India, 5–11 October 2004 and Marketing and Food Safety: Challenges in Postharvest Management of Agricultural/Horticultural Products in Islamic Republic of Iran, 23–28 July 2005.

This volume was edited by Dr. Rosa S. Rolle, Rome, Italy.

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ACKNOWLEDGMENTS

The Asian Productivity Organization and participants at the seminar convened in New Delhi, in 2004, gratefully acknowledge the hospitality extended by Mother Dairy Food Processing Limited, and the Management of the Azadpur Market.

The hospitality extended by Arjomandi Trading Company; Green Plants of Life Co. Ltd., and the Fruit and Vegetable Market situated within the Municipality of Tehran Iran were also greatly appreciated by the Asian Productivity Organization and participants at the seminar convened in Tehran, Islamic Republic of Iran.

FOREWORD

Recent regional economic growth and changes in dietary patterns have made both the production and consumption of fruit and vegetables increasingly important. The fruit and vegetable sector has a vital role in farm income enhancement, poverty alleviation, food security, and sustainable agriculture in Asia, especially in developing countries. This sector, however, suffers greatly from postharvest losses. Some estimates suggest that about 30–40% of fruit and vegetables are lost or abandoned after leaving the farm gate. Huge postharvest losses result in diminished returns for producers. International markets reject fruits and vegetables containing unauthorized pesticides, with pesticide residues exceeding permissible limits, and with inadequate labelling and packaging. Similarly there have been increasing concerns over food-borne diseases and poisoning such as *Escherichia coli* or *Salmonella* outbreaks.

Obviously, postharvest management determines food quality and safety, competitiveness in the market, and the profits earned by producers. The postharvest management of fruit and vegetables in most developing countries in the region is, however, far from satisfactory. The major constraints include inefficient handling and transportation; poor technologies for storage, processing, and packaging; involvement of too many diverse actors; and poor infrastructure.

In light of the incidence of the huge postharvest losses in the region and new challenges faced under trade liberalization and globalization, serious efforts are needed to reduce postharvest losses, especially of fruit and vegetables. This would include linking operations and actors involved more closely and systematically, modernizing marketing infrastructure and technologies, capacity building of individual actors, and strengthening the policy/institutional settings for better marketing. The concerted efforts of all, including the private and public sectors, are required to alleviate these constraints.

To discuss the issues and challenges in strengthening postharvest management of fruit and vegetables, the APO organized two seminars. The first seminar on the "Reduction of Postharvest Losses of Fruit and Vegetables" was hosted by the Government of India in New Delhi from 5 to 11 October 2004 (*hereafter called the India Seminar).* This seminar discussed recent developments in management of postharvest losses of fruit and vegetables, and issues and constraints in reducing postharvest losses. The second seminar on "Marketing and Food Safety: Challenges in Postharvest Management of Agricultural/Horticultural Products", was hosted by the Government of Islamic Republic of Iran from 23 to 28 July 2005 (*hereafter called the Iran Seminar*). The latter seminar focused on emerging marketing and food safety issues and challenges in the postharvest management of fruit and vegetables, and impediments in addressing them.

This publication is a compilation of the selected resource papers and country papers presented at the seminars. I hope that it will serve as a useful reference on the subject in the Asia-Pacific and elsewhere.

The APO is grateful to the Government of India for hosting the India Seminar; and the National Productivity Council (NPC), and the Department of Agriculture and Cooperation of the Ministry of Agriculture for implementing the program. We express our gratitude for the Government of Islamic Republic of Iran for hosting the Iran Seminar; and the National

Iranian Productivity Organization (NIPO), and Agricultural Planning and Economic Research Institute (APERI) of the Ministry of Jihad-e-Agriculture for implementing the program. Special thanks are due to the resource speakers and the participants for their valuable contributions, as well as, Dr. Rosa Rolle, UN Food and Agriculture Organization, Rome for editing the present volume.

SHIGEO TAKENAKA
Secretary-General

Tokyo
November 2006

PREFACE

Postharvest priorities across the globe have evolved considerably over the past four decades, from being exclusively technical in their outlook, to being more responsive to consumer demand. Consumer-driven trends which have contributed to this shift include rising incomes in urban areas, changing dietary habits, more women in the work-place, reduced time for meal preparation and growing demand for safety, quality and convenience. Other factors such as globalization, urbanization and the need to achieve efficiencies and reduce costs have also contributed significantly to this shift in priorities and continue to re-shape and restructure the fresh produce sector.

Growing populations across the Asia-Pacific region continue to create demand for fresh produce and processed horticultural products. Meeting these requirements as well as those of export markets necessitates assuring quality and safety in both domestic and export supply chains. Capacities must therefore be developed across the region in order to respond to consumer and market demand and to avert the risk of large numbers of small farmers becoming marginalized. At the same time, Governments in the region must develop a vision for the development of the postharvest sector and facilitate activities within the sector in order to realize that vision.

It has been a pleasure for the Agricultural Support Systems Division of the Food and Agriculture Organization (FAO) to provide technical support to the APO Seminar on the Reduction of Postharvest Losses in Fruits and Vegetables, convened during the period 5–11 October 2004 in India, and the Seminar on Marketing and Food Safety: Challenges in Postharvest Management of Agricultural/Horticultural Products, convened in Iran on 23–28 July 2005. FAO is also pleased to collaborate with the APO in collaboratively publishing this compilation of the papers and proceedings of both seminars. It is our hope that serious consideration will be given to the recommendations of both seminars in shaping the future development of the postharvest sector of the Region.

Geoffrey C. Mrema
Director
Agricultural Support Systems Division
Food and Agriculture Organization of the United Nations

Rome
November 2006

SUMMARY OF FINDINGS

Asian Productivity Organization (APO) organized two seminars to address postharvest management issues in the Asia-Pacific Region.

The first seminar on the "Reduction of Postharvest Losses of Fruit and Vegetables" was hosted by the Government of India in New Delhi from 5 to 11 October 2004 (*hereafter called the India Seminar).* The program was implemented by the National Productivity Council (NPC) with financial and technical collaboration of the Department of Agriculture and Cooperation, Ministry of Agriculture. Fourteen participants representing 11 APO member countries and by 5 resource persons attended.

The second seminar on "Marketing and Food Safety: Challenges in Postharvest Management of Agricultural/Horticultural Products", was hosted by the Government of Islamic Republic of Iran from 23 to 28 July 2005 (*hereafter called the Iran Seminar*). The National Iranian Productivity Organization (NIPO), and Agricultural Planning and Economic Research Institute (APERI) of the Ministry of Jihad-e-Agriculture implemented the program. Twenty participants from 12 APO member countries and 6 resource persons participated. Six observers from the host country also took part.

The objectives of the India Seminar were to: discuss recent developments in postharvest losses in fruits and vegetables in member countries; identify issues and constraints to reducing postharvest losses; and to define strategies and measures to reduce such losses. While the Iran seminar discussed: marketing and food safety issues and challenges in the postharvest management of fruits and vegetables; issues and impediments to improving the marketing and safety of fruits and vegetables; and measures to resolve these issues.

The program of each seminar included the presentation and discussion of resource papers by experts, presentation country papers by participants, a workshop (group discussions) to reflect on and focus on the critical issues, and field visits designed to provide a first-hand appraisal of postharvest handling and processing of fruits and vegetables in the respective host countries.

The Workshop convened during the India Seminar identified a number of technical issues which impact upon horticultural chain management and recommended solutions to address these technical issues. While outputs of the working groups at the Iran Seminar, were synthesized into a framework for postharvest development in APO member countries. The outputs of their findings at the respective seminars are summarized below:

India Seminar

Two working groups identified issues/problems in reducing harvest and postharvest losses of fruit and vegetables in the region and formulated recommendations to address them. The outputs of Group I and Group II are summarized in Table 1 and Table 2, respectively.

Table 1. Issues/problems in Harvesting, Preparation for Marketing, Storage and Transportation of Fruits and Vegetables, and Recommended Solutions

Operation	Issue/problem	Strategy	Action Plan	Responsibility
Harvesting index	No established maturity index for some commodities; lack of maturity index for local and export markets	Research and development with emphasis on quality, safety and sustainability	Develop maturity indices	Government, universities, stakeholders in the handling chain, donors and development agencies (FAO), ADB
	Low adoption of established indices; price and distance to market influence adoption	Develop farmer-friendly harvest indices Conduct extension activities	Create awareness on appropriate harvest indices through training, preparation of manuals, posters, etc.	APO, NPO, FAO, ADB
Harvesting methods and time of harvesting	Rough handling; untimely harvesting	Create awareness on appropriate methods and time of harvesting	Conduct training, disseminate information and safety practices	FAO, APO, NPO
	Lack of appropriate and/or poorly-designed harvesting tools, equipment and harvest containers	Research and development focusing on design and efficiency of harvesting tools, and equipment		Donors and development agencies, universities, research institutions
Field sorting, grading and packing	Inadequate field sorting, grading and packing protocols for commodities that lend well to field packing	Establish sorting, grading and packing protocols for certain commodities Educate the farmers and stakeholders	Training of farmers and stakeholders; information materials development and dissemination	Government and related institutions and cooperatives, stakeholders, FAO
Pre-cooling	Lack of and costly pre-cooling facilities	Create a good policy environment which promotes investment and formation of alliances/commodity-based clusters to overcome constraints of limited number of facilities	Encourage subsidy from government and investment from the private sector	Government, private sector, cooperatives

	Lack of knowledge about pre-cooling technology at commercial scale; lack of information on cost benefits of pre-cooling technology	Research and development focusing on the use of pre-cooling on a commercial scale	Request technical assistance to obtain cost-benefit information on pre-cooling technology applied on a commercial scale	Development organizations like FAO, UNDP, USAID, EU, ADB
Transportation	Poor infrastructure (roads, bridges) and lack of appropriate transport systems; lack of refrigerated transport	Encourage investment from private sector and policy support from government	Provision for logistics and management to lower cost and facilitate efficiency of distribution or movement of commodities Conduct cost-benefit studies on efficient and appropriate transport systems	Government, NGO, development organizations (FAO, EU, USAID, UNDP, ADB)
	Poor temperature management, loading and unloading practices	Create awareness on proper transport system management	Conduct training, seminars; develop and disseminate information materials	APO, NPO, FAO
Storage	Shortage of storage facilities at the farm level and refrigerated storage at the markets, ports	Create favorable policy environment for investment Research and development to determine cost and benefit of storage systems	Encourage financial support from government and private sector Conduct cost-benefit analysis on different storage systems	Government, local private sector, donor agencies (EU, DFID, USAID, FAO)
	Poor temperature conditions, including sanitation of the storage room and facilities	Create awareness on the correct operations and management of storage facilities	Conduct training of storage operators and other handlers	APO, NIPO, FAO
	Lack of knowledge on temperature requirements and ethylene sensitivities of different commodities for mixed loading	Research and development focusing on temperature, relative humidity, ethylene sensitivities of different commodities under storage	Conduct studies and disseminate findings	FAO, APO, NPO

Table 2. Issues/problems in Grading, Packaging, Processing and Marketing of Fruits and Vegetables, and Recommended Solutions

Issue	Problem	Strategy	Action Plan	Responsibility
Grading	Lack of national standards and poor enforcement of standards	Develop national standards	Assessment, research and development; dissemination, implementation and maintenance through training and demonstration, etc.	Government & Standard regulating authority and farmers' associations, APO, NPO, FAO, etc.
	Lack of skill, awareness/ financial resources	Capacity building	Awareness, motivation, training and government financial support	
Procurement centers/ Packing-house/ Grading Facilities	Lack of collection centers/ packinghouses/grading facilities	Government support for clustering	Identify strategic locations	SHG, Farmers' association, Financial institutions (e.g., ADB, World Bank, etc.), Government
Packaging and Labeling	Inadequate packing technology/suitable packaging (for transportation, storage, and consumers)	Develop/adapt from existing technologies	Develop suitable packaging technology fit for sites/ Commercialization	Government, NPO, APO, FAO, ADB, World Bank, etc.
	Lack of skill, and awareness of appropriate use of packaging/Financial resources	Capacity building	Awareness, motivation, training and government financial support for stakeholders for appropriate use of packaging technologies and materials	
	Negative environmental impact of packaging	Government regulation	Development of regulatory policies and regulations	Government and related institutions
	Lack of suitable labeling	Formulation of regulatory system	Develop appropriate regulatory policies/systems	Government and related institutions

Minimally processed; Fresh-cut; Ready-to-eat/cook	Inadequate knowledge of access to appropriate technologies for anti-browning, protection from microbial contamination	Capacity building and information dissemination especially to small processors	Develop suitable technology Awareness and training for stakeholders especially small processors	Government, NPO, APO, FAO, ADB, World Bank, etc.
Secondary Processing	Limited availability of suitable varieties for processing	Develop suitable varieties Disseminate Information to small processors	Collection and introduction of germplasm for breeding program Dissemination of information	Government, Private sector
	Inadequate appropriate processing technologies	Research and Development	Develop and/or adapt appropriate technologies	Government, Private sector
	Inadequate commercialization of new technologies and lack of basic infrastructure	Government support (technical, policy and infrastructure, etc.)	Establishing pilot plants Do cost/benefit cost and consumer studies	Government, Private sector
	Development of novel/niche products	Research and Development	Develop innovative niche products Commercialize indigenous products	Government, Private sector
	Inadequate suitable facilities/ infrastructures	Research and Development	Develop suitable facilities/ infrastructures	Government, Private sector
	Lack of processed product promotion	Product awareness	Promotion/Exhibition Fair Mass media announcement Exemption of tax and financial support to the industries	Government, Private sector
Marketing	Limited market information and lack of marketing strategies	Establish National/Regional information networking system	Develop market information systems and marketing strategies	Government, Private sector
	Inadequate market infrastructure	Development of market centers at different levels	Construction of suitable market infrastructure	Government, Private sector
	Inability to market products in domestic and international markets	Develop strategic alliances with multinational companies and corporations	Publicity and advertising through mass media	Government, Private sector

Iran Seminar

The participants deliberated on issues and problems in horticultural chain management in the region and identified a number of actions to resolve them. The collective recommendations of the participants were synthesized into a framework for development of horticultural chain management in the region (Table 3).

Table 3. Regional Framework for Horticultural Chain Management

Issue	Causes	Recommendations	Responsibility
1. Inadequate two-way dialogue between government and stakeholders	Lack of vision backed by strategies by government for the horticultural value chain	1. Develop a detailed strategic plan to support the vision for horticulture value chain 2. Develop specific industry strategic development plans 3. Form industry peak body councils comprising producers, processors, wholesalers, retailers, logistic sector, exporters	1. International organizations working through government 2. Relevant ministries to facilitate the formation of the councils
2. Poor decision making by all chain participants	Lack of awareness that information exists, lack of information itself, lack of ability to use the information	1. Make participants aware through media campaigns, principally radio and posters, that information exists 2. Provide production, marketing and technical information 3. Train users in the use of the information	1. Ministry of Agriculture, Ministry responsible for food processing and industry 2. Ministry of Agriculture to facilitate the provision of the information, including market price reporting systems 3. International organizations, tertiary institutions, para-governmental organizations, NGOs
3. Poor basic infrastructure affecting production planning and postharvest infrastructure	Poor planning, poor funding by government, few incentives	1. Use horticultural value chain vision 2. Provide financial incentives both in terms of front and back ends 3. Provide laws that provide investors with assurance of security	1. Vision: Ministry of Agriculture 2. Ministry of finance, banks, private sector 3. Relevant ministries. 4. International donors and lending institution

4. Inappropriate and lack of adequate technology	Poor linkage with universities; absence of all horticulture value chain participants in research and development and in decision making; lack of holistic approach in decision making; poor extension services; lack of support funding	1. Make research by universities and research and development institutions more commercially oriented through a rewards system 2. Greater use by international organizations in making available existing appropriate technology 3. Fund greater dissemination of existing technology and research results 4. Increase the capacity of the extension service in production, postharvest handling, and marketing	1. Funding by relevant ministries 2. International organizations 3. Universities, and research and development institutions
5. Low level of organization	Unwillingness to collaborate; lack of understanding of the benefit of collaboration; lack of collaboration amongst relevant ministries	1. Adherence to the vision and its supporting developmental strategies 2. Use facilitators with communication skills as a precondition to getting further aid 3. Government legislation to support vertical (contract) and horizontal (cluster farms)	1. International donors through government 2. All levels of government legislation – national, regional, and local
6. Small and scattered nature of horticulture	Land tenure legislation	1. Legislation 2. Use facilitators to show the benefits of grouping 3. Build better public utilities (roads, water, and electricity)	1. Relevant levels of government from national to regional through to local government 2. International donors through government 3. National, regional and local governments

7. Unsafe food	Poor water quality, chemical and microbiological hazards, poor worker hygiene, poor market sanitation, lack of legislation	1. Enact food safety legislation with meaningful working regulations and trained personnel to enforce the Act 2. Implement GAP, GMP, HACCP schemes 3. Provide appropriate food safety and quality laboratories, along with trained scientists	1. Relevant ministries 2. International agencies through government 3. Government and private sector
8. Poor quality	Poor inputs (water, seed, fertilizer, agricultural chemicals), poor handling, lack of standards, lack of maturity indices, inappropriate packing along with poor and expensive packaging material, poor integrated (cold) chains, minimum involvement of the private sector, environmental factors	1. Have explicit standards covering domestic and international markets with appropriate inspection capabilities 2. Train all horticulture value chain participants 3. Provide incentives for private sector involvement 4. Undertake awareness campaigns 5. Ensure relevant and true-to-type seed availability through governmentally approved seed sellers 6. Quality standards to be formulated by stakeholders with a facilitating role by government 7. Appropriate inputs	1. International agencies through relevant ministries 2. Relevant ministries 3. Ministry of Finance 4. Consumer associations funded by government. Relevant ministries 5. Relevant ministries 6. International agencies through government to increase capacity of stakeholder organizations to self-regulate 7. Private sector regulated by government
9. Inability to initiate and sustain linkages with international markets	Poor standards, no vision, little promotion, few incentives, lack of economies of scale, lack of competitiveness, market information, non-membership of WTO, instability of supply	1. Ensure meaningful volumes, quality, stability and timely commitment to deliver 2. Comply with international benchmarks 3. Make greater use of international market researchers & market development specialists	1. Private sector facilitated by government through appropriate infrastructure 2. International organizations 3. Government through international organizations 4. Government using outside experts

		4. Have strong chain linkages that reduce losses and ensure competitiveness 5. Develop strategies that emphasize trade within the member countries' immediate regions and include harmonization of standards between collaborating countries 6. Develop and ensure the success of a number of pilot scale projects within a specific time frame in order to establish a demonstration affect 7. Expedite membership of WTO	
10. Low and erratic producer prices	Poor grower involvement in the value chain, poor planning by growers, poor market information	1. Refer to vision and specific industry strategies development plans 2. Encourage development of value chains 3. Establishing collaborative marketing organizations such as cooperatives, self help groups, and farmer associations 4. Establish farmer markets	1. Relevant ministries and private sector 2. Relevant ministries, private sector, NGO's 3. Relevant ministries, private sector, NGOs

THE WAY FORWARD

The Framework developed constitutes a sound first step toward improving postharvest in the Asia-Pacific Region. Moving this framework into an action plan requires a number of subsequent steps.

The Framework must firstly be disseminated within member countries through the conduct of national seminars. Discrete sections of the framework should then be used as a basis for the development of specific working plans. Issues pertinent to food safety, quality and international marketing for example, might be separately tackled. Assistance from international agencies should be sought.

Closer collaboration of like projects, especially in the area of postharvest should be promoted with the sharing of efforts and especially the sharing of results. Regional networking initiated by member countries could be facilitated through international agencies.

1. RECENT DEVELOPMENTS IN REDUCING POSTHARVEST LOSSES IN THE ASIA-PACIFIC REGION

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INTRODUCTION

Food security, both in terms of availability and access to food, poses a challenge to rapidly growing populations, in environments of dwindling land and water resources. The horticultural sector has established its credibility for improving land use, and generating employment and nutritional security.

Horticulture, which includes the production of fruits, vegetables, flowers, spices, medicinal and aromatic plants and plantation crops has emerged as a major economic activity in Asia and Pacific. The Asia-Pacific region contributes to more than 50% of the world's acreage under fruits and vegetables and produces a diversity of fruits such as apples, bananas, oranges, grapes and mangoes in addition to tropical and sub-tropical fruits such as pineapples, papayas, guavas, litchi and passion fruit.

For the most part, fruits and vegetables are not considered to be primary sources of carbohydrate, protein and fat. However, those with storage roots and tubers are rich in carbohydrate, particularly starch, in amounts comparable to the cereal crops, and can be used as staple foods. Leguminous vegetables supply as much as 14% protein, while dry seeds supply even more. The lipid content of most vegetables is less than 0.1%. Most fruits, vegetables and root crops are rich in minerals, carotene (Pro-vitamin A) and vitamin C, and are reasonably good sources of trace elements such as copper, manganese and zinc, which act as enzyme cofactors. The nutrient content of fruits and vegetables varies in accordance with the fruit or vegetable variety, cultural practices, stage of maturity, postharvest handling and storage conditions. Natural physiological and biochemical activity in fruits and vegetables results in compositional changes following harvest.

Apart from their nutritive value, other constituents of fruits and vegetables which deserve attention include antioxidants, bioflavonoids, flavor compounds and dietary fibre. Often, the leafy portion of some important vegetables is discarded while the fleshy portion is consumed with little recognition for the fact that rich sources of nutrients such as calcium, iron, vitamin-C and carotene go to waste (Table 1). Apart from the common and generally costly fruits, a large number of indigenous fruits, examples of which include 'Aonla' and 'Baelfruit' are rich sources of ascorbic acid (Vitamin-C) and riboflavin (Vitamin-B_2). Some tropical fruits and vegetables are known to have therapeutic properties and are popularly used in traditional medicine in several countries of the region.

Table 1. Micro Nutrient Content of Edible and Leafy Portions of Vegetables

	CALCIUM (Mg/100g)	IRON (Mg/100g)	CAROTEN (µg/100g)	VITAMIN-C (Mg/100g)
COLOCASIA	40	0.42	24	0
COLOCASIA LEAVES	227	10.0	10,278	12
DRUMSTICK	40	0.18	110	120
DRUMSTICK LEAVES	440	7.0	6,780	220
KNOL KHOL	20	1.54	21	85
KNOL-KHOL GREEN	740	13.5	4,146	157
RADISH	35	0.4	3	15
RADISH LEAVES	265	3.6	5,295	81
TURNIP	30	0.4	0	43
TURNIP GREEN	710	28.4	9,396	180

STATUS OF POSTHARVEST HANDLING

Asia and the Pacific region have witnessed rapid growth in horticultural development. Changes in dietary habits owing to increasing incomes continue to accelerate demand for horticultural produce in the region. This increased demand must be met in an environment of shrinking land and water resources. At the same time, developments in science and technology could provide an opportunity for intensifying the production of horticultural produce.

Poor infrastructure for storage, processing and marketing in many countries of the region contributes to a high proportion of waste, which average between 10 and 40%. Major infrastructural limitations also continue to impose severe constraints to domestic distribution as well as to the export of horticultural produce. Considerable waste occurs owing to the fact that small farmers lack resources and are unable to market their produce and implement suitable postharvest handling practices. Spoilage of fresh produce is also accelerated by the hot and humid climate of the region. Postharvest management and processing of horticultural produce has assumed considerable significance in light of increasing demand for fruits and vegetables in the region.

The World Food Conference convened in Rome in 1974, drew attention to the concept of postharvest food loss reduction as a significant means to increase food availability. The Special Action Program for Food Loss Prevention, of the Food and Agriculture Organization of the United Nations (FAO) initially focused on durable food grains, owing to their prominence in developing country diets. An Expert Consultation on Food Loss Prevention in Perishable Crops, mainly covering fruit and vegetables was held in Rome in 1980.

Although India is a major producer of horticultural crops, many Indians are unable to obtain their daily requirement of fruits and vegetables and the Human Development Index (HDI) is very low. Considerable quantities of fruits and vegetables produced in India go to waste owing to improper postharvest operations and the lack of processing. This results in a considerable gap between gross food production and net availability.

It should be noted that the production of fruits and vegetables is of significance only when they reach the consumer in good condition and at a reasonable price. The concept of placing exclusive emphasis on increased production of fruits and vegetables is self-defeating. It is important to see how much of the produce goes through marketing channels and finally reaches the consumer. Efforts should be made to integrate production with postharvest management since postharvest loss reduction and utilization have considerable bearing on food availability. It is known that food loss reduction is normally less costly than equivalent increases in food production. Reduction of postharvest losses is essential in increasing food availability from existing production. The success of production lies in the proper distribution of produce and its subsequent utilization by the consumer with zero waste in the process i.e., 100% utilization of production in one form or another should be the motto.

Opportunities exist in both domestic and international markets for fresh and processed fruits and vegetables.

This paper discusses the need for a sound foundation in developing integrated postharvest management systems for fruits and vegetables, with proper infrastructural facilities and logistical support.

CAUSES OF POSTHARVEST LOSSES

Postharvest losses are caused by both external and internal factors.

External Factors Which Lead to Postharvest Losses

Mechanical Injury

Fresh fruits and vegetables are highly susceptible to mechanical injury owing to their tender texture and high moisture content. Poor handling, unsuitable packaging and improper packing during transportation are the cause of bruising, cutting, breaking, impact wounding, and other forms of injury in fresh fruits and vegetables.

Parasitic Diseases

The invasion of fruits and vegetables by fungi, bacteria, insects and other organisms, is a major cause of postharvest losses in fruits and vegetables. Microorganisms readily attack fresh produce and spread rapidly, owing to the lack of natural defense mechanisms in the tissues of fresh produce, and the abundance of nutrients and moisture which supports their growth. Control of postharvest decay is increasingly becoming a difficult task, since the number of pesticides available is rapidly declining as consumer concern for food safety is increasing.

Internal Factors

Physiological Deterioration

Fruit and vegetable tissues are still alive after harvest, and continue their physiological activity. Physiological disorders occur as a result of mineral deficiency, low or high temperature injury, or undesirable environmental conditions, such as high humidity. Physiological deterioration can also occur spontaneously owing to enzymatic activity, leading to overripeness and senescence, a simple aging phenomenon.

SCOPE AND STRATEGIES

The unnecessary waste of valuable commodities can be checked by processing into value added products. Considerable scope exists for both domestic and export trade in fruits and vegetables in India. This will, however, only be achieved with improved distribution systems and processing of these highly perishable horticultural commodities. The food processing sector is employment driven and it is reckoned that an investment of Rs.1000 crores can provide employment to 54,000 persons in that industry. The even marketing of fruits from areas of abundance to places of scarcity will stabilize fruit and vegetable prices. Proper postharvest management practices for minimizing losses and for improving marketing are generally not followed in India.

Raw Material

No matter how perfect postharvest operations are, good returns cannot be obtained from poor quality raw materials. The selection of suitable varieties is, therefore, essential. Linking production to postharvest operations is essential to optimizing results. Pre-harvest parameters such as selection of proper planting material, crop management, and disease and pest control must be geared toward producing high quality produce. Once the crop is ready for harvest, attention must be paid to the harvesting technique/procedure. Poor harvesting practices can lead to irreparable damage to horticultural produce. It is therefore necessary to standardize maturity indices and harvesting techniques for each and every fruit and vegetable in order to minimize damage at the time of harvest.

Packing Stations

There is an absolute lack of the concept of packing house establishments in India. Fruits and vegetables are generally packed in the field without any pretreatment. Some are even transported without any packaging. In developed countries on the other hand, fruits and vegetables are generally selected, cut, placed in bulk containers and transported to packing stations where they are trimmed, sorted, graded, packed in cartons or crates and cooled. They are temporarily placed in cool storage for subsequent loading or are loaded directly onto refrigerated vehicles, and transported to market. A number of important operations are also carried out at packing stations. These include SO_2 fumigation, fungicidal dipping, surface coating with wax, degreening of citrus, ripening and conditioning, vapor heat treatment etc.

Due to the lack of proper packaging systems in India, large volumes of the inedible portions of vegetables such as cauliflower, peas etc. are transported to wholesale markets from the field. They are discarded to various degrees and large quantities of biomass which could be used as value added products are wasted. Removal of these inedible vegetable portions prior to marketing would reduce both transportation costs and environmental pollution. These inedible vegetable parts ultimately undergo decomposition, cause sanitation problems and produce gases which are detrimental to the environment. Farmer's cooperatives and other agencies should, therefore, be encouraged to establish packing stations at nodal points to augment the marketing of fresh horticultural produce.

Primary Processing

Unlike durable crops such as cereals, pulses and oilseeds, fresh fruits and vegetables are highly perishable, and must be marketed immediately after harvesting without primary processing. Fruit and vegetables generate large quantities of valuable waste that ends up as garbage. However, if they are gainfully utilized at the proper time they can become value added products. Vegetables such as cauliflower, peas, leafy vegetables, etc. can be minimally processed at packing stations immediately after harvesting, through the removal of inedible parts, following which they can be marketed in metro city markets in unit packs. Between 10 and 60% of the fresh fruits and vegetables marketed and purchased by consumers in India are rejected as inedible. In villages or small towns the inedible portions of fruits and vegetables are either fed to animals or are discarded as garbage by consumers in metro cities.

Primary processing of food crops other than horticultural crops has its origin from the dawn of civilization. It was a necessary step to the consumption of foods such as rice, wheat, oilseeds, etc. Processing not only renders these commodities edible, but also adds value to them. Value-addition to horticultural crops was never considered essential, owing to the fact that many of these fruits and vegetables, e.g., tomato, melon, cucumber, carrot, etc. could be directly consumed after harvesting. Today, there is considerable interest in processing to add value, as well as to reduce losses in fruits and vegetables.

Packaging

Packaging is an integral element in the marketing of fresh horticultural produce. It provides an essential link between the producer and the consumer. Owing to its favorable properties, wood has remained the main packaging material for fruits and vegetables. Timber conservation is, however, critical in order to maintain an ecological balance, and there is an urgency to identify substitutes for the use of timber in an effort to protect forest resources in many developing countries. Packaging has been identified as one of the most important areas where substitution of wood is not only possible but also obviously desirable. Considerable work has been done by different agencies in introducing alternative types of packaging. Corrugated fibre board (CFB) containers consume one third of the wood required for producing timber boxes of the same size. CFB boxes can also be fabricated from kraft paper produced from bamboo, long grasses and many other types of agricultural residues like bagasse, paddy, cotton stalk, jute stick, wheat straw and recycled paper and cardboard. Packaging produced from timber is often used as a source of firewood, owing to the severe shortage of fuel wood in India. CFB cartons on the other hand are recycled as pulp or paper. Thus switching over from wood to CFB boxes for the packaging of horticultural produce is a very practicable and environmentally friendly option.

Increased use of corrugated cartons for local distribution of produce could be accomplished with improvement in the quality of boxes produced in India. The ventilated CFB box which contains ventilated partitions, and which was developed at the IARI was found to be ideal for the packaging and transportation of fruits, owing to the comparably minimal level of bruising observed in these boxes. Cushioning materials used in the packaging of fruits and vegetables in wooden boxes include dry grass, paddy straw, leaves, sawdust, paper shreds etc., all of which end up as garbage and add to environmental pollution in cities. Moulded trays or cardboard partitions used in CFB boxes are, however, easily recycled.

Palletization

Loading and unloading are very important steps in the postharvest handling of fruits and vegetables but are often neglected. The individual handling of packaged produce in India leads to mishandling and to high postharvest losses in India. With the introduction of CFB boxes, serious consideration should be given to the introduction of palletization and mechanical loading and unloading of produce particularly with the use of fork-lift trucks, in order to minimize produce mishandling.

Storage

The lowest temperature that does not cause chilling injury is the ideal storage temperature for fresh fruits and vegetables. Mechanical refrigeration is generally used for the storage of fruits and vegetables. Mechanical refrigeration is, however, energy intensive and expensive, involves considerable initial capital investment, and requires uninterrupted supplies of electricity which are not always readily available, and cannot be quickly and easily installed. Available cold storage in India is used primarily for the storage of potatoes. Appropriate cool storage technologies are therefore required in India.

On Farm Storage

On farm storage is required in remote and inaccessible areas of India, to reduce losses in highly perishable fresh horticultural produce. The high cost and high energy requirements of refrigeration, and the difficulty of installing and running refrigerated facilities in remote areas of India, precludes the use of refrigerated storage in many parts of India. Low-cost, low-energy, environmentally friendly cool chambers made from locally available materials, and which utilize the principles of evaporative cooling, were therefore developed in response to this problem. These cool chambers are able to maintain temperatures at 10–15^{o}C below ambient, as well as at a relative humidity of 90%, depending on the season. Fruits and vegetables are stored in plastic crates within the chamber. The shelf life of the fruit and vegetables maintained in the cool chamber was reported to be increased from 3 days at room temperature, to 90 days.

Control Atmosphere/Modified Atmosphere Storage

Controlled atmosphere (CA) or modified atmosphere (MA) storage involves adjustment of the atmospheric composition surrounding commodities by removal (mainly O_2) or addition (mainly CO_2) of gases from the environment surrounding the fruits and vegetables. MA does not differ in principle from CA storage except for the fact that the concentrations of the gases are less precisely controlled. Basic requirements for CA storage include a gas tight chamber and control of the concentrations of CO_2 and O_2. When combined with refrigeration, CA markedly enhances the shelf life of fruits and vegetables.

Containerization

The use of containers for the transportation of goods was recently introduced into India. Relatively little attention has, however, been given to the use of containers for the transport of fresh horticultural produce. Containerization provides an excellent system for the shipment of goods from one place to another. Refrigerated containers are used in the transportation of fruits, vegetables and flowers in many developing countries. The design and fabrication of ventilated containers which incorporate evaporative cooling systems should be considered for the Indian context. One of the greatest advantages of the container is that it can be placed on truck or rail, without interfering with the movement of the vehicle. Palletization and containerization will go a long way in developing local and international trade.

Rapid Transportation Systems

Railways and roads are two important transportation systems for the movement of goods in India. The use of railways for the transportation of fruits and vegetables in India could be greatly enhanced by: making provisions for cooling and ventilation, providing improved handling facilities at platforms and providing storage space to accommodate the goods upon arrival at their destinations. Similarly road services could be considerably improved by widening roads, upgrading surfaces and through the introduction of one way traffic. Long waits at level crossings should be avoided by introducing flyovers at intersections in order to increase the speed and movement of goods by road. Facilities such as sheds, for temporary cool storage should be available on highways and major roads.

Cold/Cool Chain

The adoption of cold chain systems has been pivotal to trade in fruits and vegetables in developed countries. The maintenance of low temperatures at different stages of handling helps in reducing losses and in retaining the quality of fruits and vegetable. High cost and the lack of abundant uninterrupted power supplies, make it impossible to develop cold chain systems in India. Consideration should, however, be given to the development of alternative cooling systems based on evaporative cooling techniques. Systems of this type would at least reduce postharvest deterioration and extend the shelf life of fresh fruits and vegetables.

Indigenous Fruit Processing

India produces a range of indigenous tropical fruits, of excellent flavor and color. Many of these fruits are, however, underutilized. A large number are, however known for their therapeutic/medicinal and nutritive value. Consumers today are becoming increasingly conscious of the health and nutritional benefits of the food they consume, and there is an increasing tendency to avoid the consumption of chemically treated foods. Indigenous fruits can play an important role to in satisfying the demand for nutritious, delicately flavored and attractive natural foods of high therapeutic value.

Some of the fruits produced in India are, however, unappealing in the fresh form, but offer considerable potential for processing and marketing. Bael fruit for example, which has a hard shell, mucilaginous texture and numerous, is not popularly consumed as a dessert fruit in India. Kokum is yet another fruit which is not acceptable in the fresh form owing to its high level of acidity, while fresh anola has a strong astringent taste. Though some value-added fruit products are currently being manufactured on a small scale, no systematic approach has been made to utilize the potential of indigenous fruit on a large scale, owing primarily to the lack of adequate quantities of raw materials. The development of orchards and the systematic collection of raw materials are of utmost importance in developing fruit processing industries. Rather than competing in markets where products are already established, India must break new ground and create markets for value-added products from its indigenous fruit, which could offer a competitive advantage.

Processing of Unmarketable Fruits and Vegetables and Factory Waste

Considerable volumes of unmarketable and physically damaged fruits and vegetables that are without infection can be converted into value added products by processing. Bye-products of fruit and vegetable processing could also be gainfully utilized.

PUBLIC AWARENESS

Public awareness campaigns must be implemented in order to increase awareness of the costs and implication of losses after harvest/production. Fixed targets must also be established to curb postharvest losses, along the same lines as those used in family planning and other time bound national programs. Public awareness campaigns should involve scientists, as well as extension and social worker organizations, and should incorporate the use of audio visual aids and the mass communication systems, including both print and electronic media.

The Government of India is committed to providing a massive thrust to food processing and other agro-based industries in an endeavor to increase the income of farmers, create employment opportunities, diversify the rural economy and foster rural industrialization. This sector has a critical role in improving agricultural productivity, reducing waste in fruits, vegetables and other perishable food items, and improving food availability for the domestic market as well as for export markets. Fresh and processed fruits and vegetables offer opportunities for both the domestic market and for international trade. In today's liberalized policy environment, India is well placed for both local and foreign investment in the food processing sector.

DIVERSIFICATION AND VALUE ADDITION

In the past, fruits and vegetables were processed primarily into jams, jellies, chutneys, etc. Canning and dehydration were considered to be the most sophisticated methods of processing, prior to the discovery of rapid freezing. Cold storage has considered the only method suited to extending the shelf life of fruits and vegetables, until the development of modified and controlled atmosphere storage. Relatively little emphasis was placed on the handling of fresh fruits and vegetables.

In recent times, considerable emphasis has been placed on the handling of fresh fruits and vegetables. Canning has become practically obsolete and methods such as aseptic packaging, cryogenic freezing, deep freezing accelerated freeze drying, controlled and modified atmosphere storage, shrink wrapping etc. have been increasingly used in extending the shelf life of fruits and vegetables. These technologies must be adopted if India is to keep apace with the rest of the World.

CONCLUSION

A number of deficiencies currently exist in the postharvest management and processing of fruits and vegetables in India. Action must be taken in order to upgrade systems, in order to reduce the levels of postharvest losses in India. In a civilized world, when millions go hungry, it would be a crime to allow postharvest losses to continue. It is unfortunate that in India, policy makers and planners set targets for increased production without making any effort to reduce postharvest losses.

Expenditure on crop production is required on an annual basis, while the establishment of infrastructural facilities for postharvest operations is a one time capital investment which must be undertaken and compensated for by the annual savings from reducing postharvest losses. Proper infrastructure, logistics and management and human resources are essential to improving postharvest management and marketing of fruits and vegetables.

2. IMPROVING POSTHARVEST MANAGEMENT AND MARKETING IN THE ASIA-PACIFIC REGION: ISSUES AND CHALLENGES

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INTRODUCTION

The Asia-Pacific Region accounts for approximately 30% of the world's land area. Three countries of that region: China, India and Indonesia are among the four most populous nations globally. The Region is characterized by a gradient of developmental levels which bears a strong correlation to achievements in postharvest management and capacity for agro-industrial development in its member countries.

The fruit and vegetable sector across region is increasingly shifting toward the adoption of a market-oriented focus. This shift in focus within the sector must be facilitated and supported by enabling technologies and infrastructure, postharvest handling skills, proper logistics and organization, as well as proper marketing and management skills and a supportive policy and regulatory environment. This paper will review recent trends across the region, issues and challenges which impact upon horticultural chain management and marketing and will discuss the role of governments in facilitating horticultural chain management and marketing in the region.

GENERAL TRENDS IN THE REGION

Countries of the Asia-Pacific Regions show wide variation in their income classification (Table 1). High income countries such as Japan, the Republic of China, and the Republic of Korea have, to a large extent, been successful in implementing postharvest management systems which minimize losses in perishables, while middle income countries such as the Philippines, Thailand, and Malaysia are putting in place systems and strategies designed to upgrade postharvest capacities. Many low and middle income countries continue to focus on capacity building in order to minimize losses in fruits and vegetables as they struggle to overcome technical, infrastructural and managerial constraints and maintain quality and safety.

Rising incomes, consumer demand for safety, quality and convenience, increasing levels of fruit and vegetable imports, increasing rates of urbanization, scientific and technological developments, and the growth of fast food chains and supermarkets necessitate that countries across the region put in place appropriate policies, regulatory frameworks and infrastructure, and build capacity in postharvest management and marketing, if their fruit and vegetable sectors are to remain competitive.

Table 1. Income Classification of Selected Countries of the Asia-Pacific Region

Low Income	Low-Middle Income	Upper Middle	High Income
Cambodia	China	Malaysia	Singapore
India	Fiji		Japan
Vietnam	Iran		Korea
	Philippines		Hong Kong
	Sri Lanka		
	Thailand		

Source: World Bank Indicators 2003

TRENDS IN THE FRUIT AND VEGETABLE SECTOR

The past ten years have witnessed progressive growth in fruit and vegetable production in the Asia-Pacific Region (Figure 1). According to FAO statistics, in 2004 the region accounted for approximately 31% of global fruit production and 42% of global vegetable production, with India being by far the largest producer of fruits and vegetables in the region. Indonesia, the Philippines and Thailand are also significant producers of fruits in the region, with Thailand accounting for approximately 45% of canned pineapples in world trade.

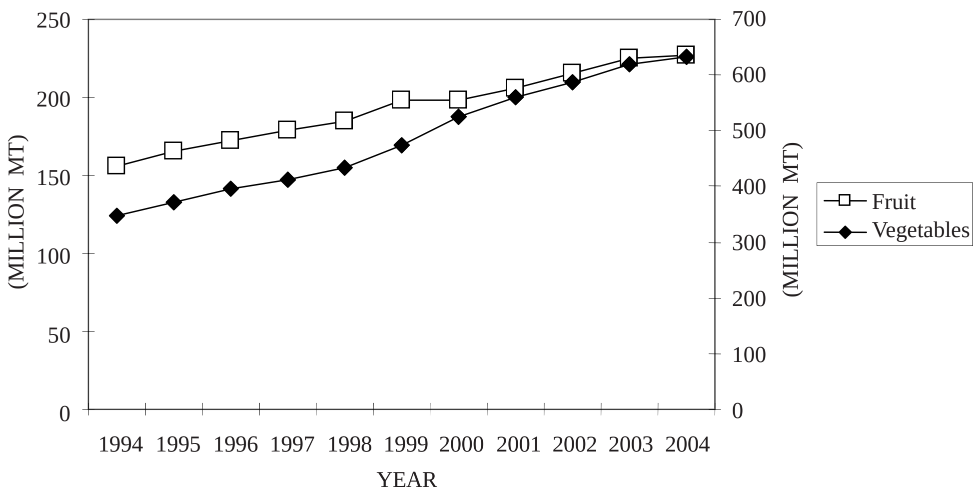

Figure 1. Trends in Fruit and Vegetable Production in the Asia Pacific Region (*Source*: FAOSTAT)

The vast majority of the region's fruit and vegetable production is consumed in local markets. According to FAO Statistics, the region produced 211 million MT of fruits in 2002, and exported a mere 15 million MT. Similarly 589 million megatons of vegetables were produced in the region in 2002, of which 12 million tonnes were exported. Major fruit and vegetable export markets reside within the region, although significant quantities of prepared fruits and vegetables are exported to the United States and the United Kingdom. Fruit and in particular vegetable imports into the region, however, continue to show an increasing trend

(Figure 2). In many cases, these imports are competitors of local produce in that they are less costly and of better quality than the local produce.

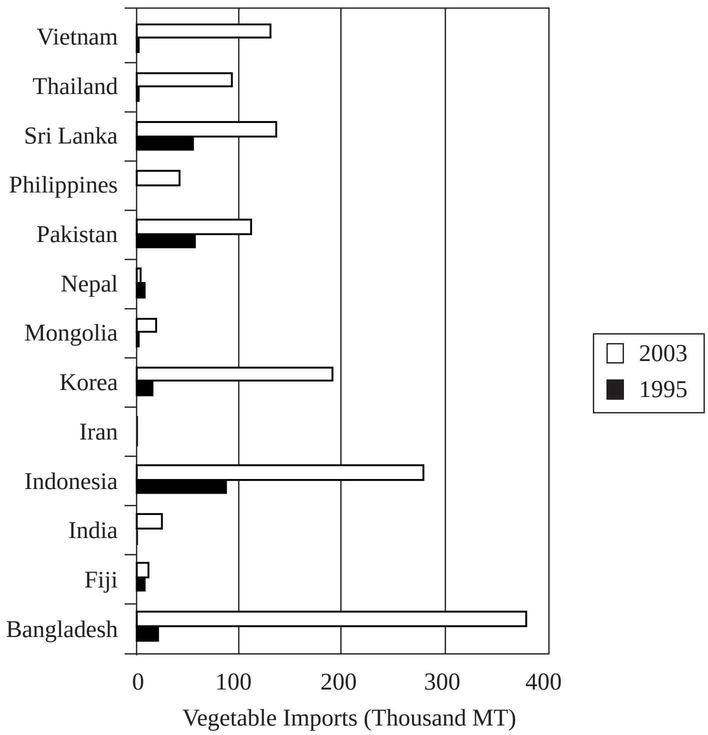

Figure 2. Vegetable Imports into Selected Countries of the Asia-Pacific Region (1995 and 2003) (*Source*: FAOSTAT)

PRODUCERS AND TARGET MARKETS

Fruit and vegetable producers in the region can be broadly grouped into four categories: small farmers; groups of farmers, clusters or cooperatives; commercial farmers and foreign entities or multinationals (Figure 3). These producers target different markets, and show a gradient in their production capabilities, access to technologies, markets information and infrastructure.

Small farmers, who operate farms of less than 1 hectare, with limited access to resources and technology, dominate the fruit and vegetable production sector across the region. Poor quality produce and high levels of postharvest losses (Table 2) occur primarily due to the use of poor quality inputs, poor cultural practices at the production level, lack of knowledge and skill in harvesting, postharvest handling, packing and packaging, inadequacies in basic and postharvest specific infrastructure in terms of pre-cooling facilities, transport, storage and marketing, lack of processing facilities, high transportation costs, poor integration of activities along the chain and complex marketing channels. The situation is further aggravated by the warm humid climates of most countries within the region.

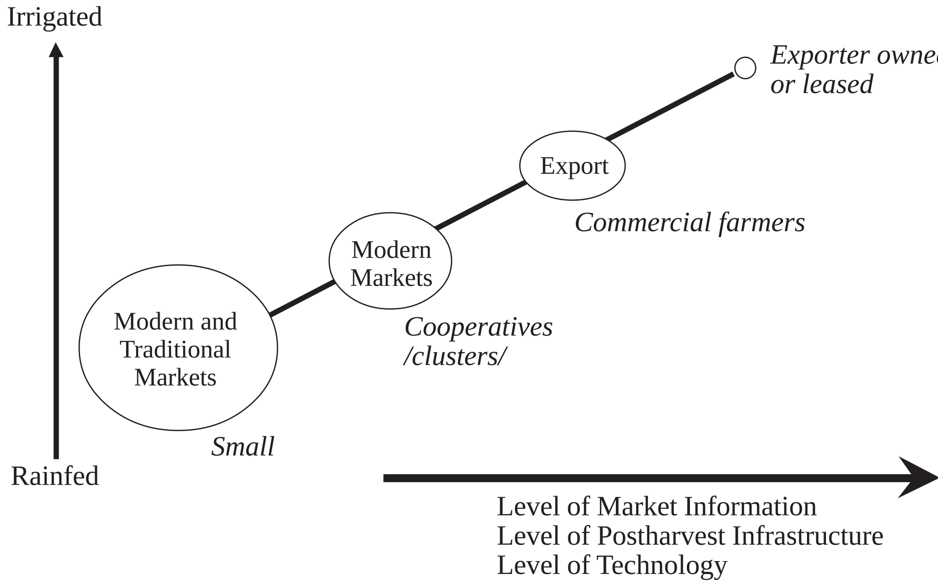

Figure 3. Categories of Producers in Countries across the Asia-Pacific Region

These small farmers generally focus on production activities, and show relatively little interest in postharvest and marketing activities which are primarily undertaken by middlemen, traders and assemblers. Their major markets include highly disorganized traditional markets such as wholesale and wet markets, though many supply the requirements of institutions, supermarkets and fast food chains. With very limited access to financial resources and technology and low returns from their agricultural production, these farmers show relatively little interest in upgrading their traditional practices and the quality of their inputs.

Table 2. Estimated Levels of Postharvest Losses in the Asia-Pacific Region

Country	Estimated Level of Losses (%)
India	40
Indonesia	20–50
Iran	>35
Korea	20–50
Philippines	27–42
Sri Lanka	16–41
Thailand	17–35
Vietnam	20–25

The growing need to supply institutional markets, supermarkets and hypermarkets in the region with produce of standardised quality, has stimulated the development of partnerships among suppliers in order to meet volume requirements, to assure consistency of supplies, and to enhance efficiency in marketing. Commodity clusters, farmer organizations, and cooperatives are some examples of such partnerships. Many of these entities in lesser developed countries of the region are facilitated by infrastructural support and input from governments. In the more advanced countries of the region such as the Republic of China, the

Republic of Korea and Thailand, cooperatives operate modern marketing systems which integrate a cold chain, alongside the traditional marketing system.

Buyer-supplier partnerships such as contract farming arrangements also facilitate fruit and vegetable marketing in many countries across the region, while providing farmers access to skills, technologies, and infrastructure. The lettuce cluster in the Philippines (Box 1) provides a good example of the success of both clustering and buyer-supplier partnerships. This latter partnership is facilitated and supported by infrastructure provided by the Government.

Well equipped commercial farmers and multinationals generally undertake fruit and vegetable production for export markets. Much of this export trade is intra-regional, although limited quantities of horticultural produce and their processed products are exported internationally (Figure 4).

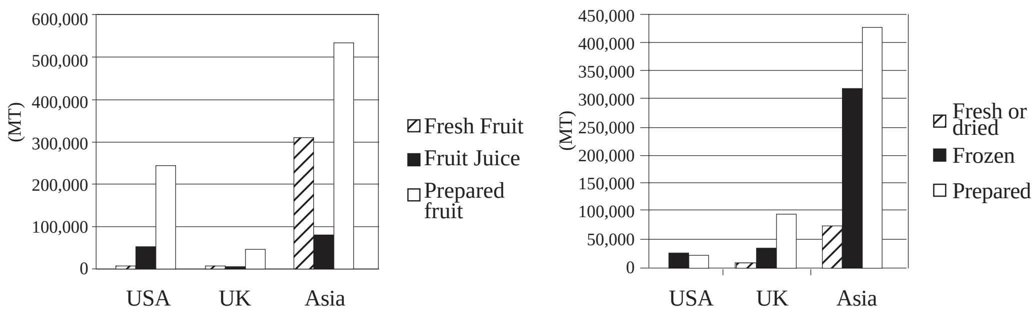

Figure 4. Major Export Markets for Fresh and Processed Fruits and Vegetables

INFRASTRUCTURE

Increased distances between production areas and markets, brought about by urbanization, necessitates the transit of produce over long distances from rural to urban centres, to feed the constantly increasing populations in these centres. Proper road infrastructure, appropriate transportation infrastructure as well as proper packing and packaging technologies are critical to minimizing mechanical injury during the transit of produce from rural to urban areas.

Innovative transportation systems, such as the use of a tram-line in the Philippines (Rapusas, 2004) have greatly facilitated small farmers in remote areas in overcoming infrastructural obstacles in accessing inputs and in supplying fresh produce to markets at reduced cost. Piloting of this system was supported by the national government, and is currently operated by a cooperative (Rapusas, 2004).

Cold chain programs are being piloted in the Philippines, and Indonesia. Such programs are already operational in more advanced countries such as Thailand, the Republic of China, and the Republic of Korea. All of these national programs are government supported and are operated by private sector entities such as cooperatives.

Low income countries of the region have developed and implemented innovative, low cost energy efficient cool storage systems, in an effort to minimize storage losses. The zero-energy cool chamber for cooling fruits and vegetables in India (Choudhury et al., 2004) and modified cellar storage technology for the storage of mandarin oranges in Nepal (Paudel, 2004) are examples of such innovations. Research and development into the design and use of these systems has been largely supported by governments.

SAFETY AND QUALITY

Current trends point to increasing consumption of fresh fruits and vegetables in urban centres, owing to rising incomes, and growing consumer demand for produce that is safe, of high quality and conveniently packaged. To this end, some of the more advanced countries of the region have been proactive in implementing Good Manufacturing Practices and Good Agricultural Practices in fresh fruit and vegetable handling.

Much work, however, needs to be done across the region in order to promote quality and safety consciousness, and in particular to assure the use of water of appropriate quality in pre- and post-harvest operations, as well as the appropriate use of pesticides, herbicides fungicides and fertilizers during the production of fruits and vegetables. The implementation of regulatory frameworks which govern food safety and quality, laboratories and quality assurance services is required in many countries across the region.

PROCESSING

Considerable opportunity exists for processing in rural areas across the region. Lack of organized production-processing linkages, limited/antiquated processing infrastructure and technologies, and inadequate packaging; however, pose major constraints to processing activities. Partnerships among these entities could greatly enhance their operations.

The minimal processing of fruits and vegetables is an area which offers considerable potential for development of the fruit and vegetable sector, given the current growth in export market opportunities for minimally processed fruit in the region (Figure 5). Minimally processed produce, however, deteriorates at a much faster rate than does intact fruits and vegetables. Stringent quality management systems such as Good Manufacturing Practices (GMP) and Hazard Analysis and Critical Control Point (HACCP) as well as proper packaging and temperature management are, therefore, required to assure its safety and freshness.

Box 1: The Case of Lettuce Clustering in the Philippines

On the island of Mindanao, small vegetable growers in different villages of the highland province of Bukidnon have begun producing vegetables such as lettuce, carrots and garden peas for local traders at the vegetable trading post at CDO, which is situated 75 km away from the farms. A year later, an additional market (a vegetable processor supplying large fast food outlets in the metropolis) was identified in Manila, and approximately 400 kg of lettuce were transported by air on a weekly basis from Mindano to that market. Apart from the high cost of airfreight, lettuce delivered to the processor did not meet the 61% yield specified in the marketing contract, owing to the need for 16 to 20% trimming. Attaining the high quality standards of the fast food processor was a formidable challenge to the grower. However, given the grower’s determination to succeed in the farm enterprise and the processor’s recognition of this willingness, recommendations pertinent to the use of refrigeration and shipping were made by the processor, in order to reduce freight cost. The processor, in addition, readily offered technical advice on the improvement of production and postharvest practices to the grower.

The requirement to supply a 20-foot refrigerated van with 3.5 Mt of lettuce on a weekly basis, led to the formation of a cluster of lettuce growers. This cluster of growers, “the lettuce cluster” shared production technologies to come up with a common quality standard, and began making weekly shipments to the processor in Manila. With the use of refrigerated transportation, the trimmings were significantly reduced to a maximum of 10% and the processor's yield recovery specification of 61% was successfully met.

This supply chain was facilitated by equipment inputs in the form of cold chain infrastructure from the government. Its successes have also provided the impetus for other independent, small lettuce growers to join in the cluster. This development has given the cluster a window of opportunity to expand its production volume and, in turn its captive market.

Rapusas (2004)

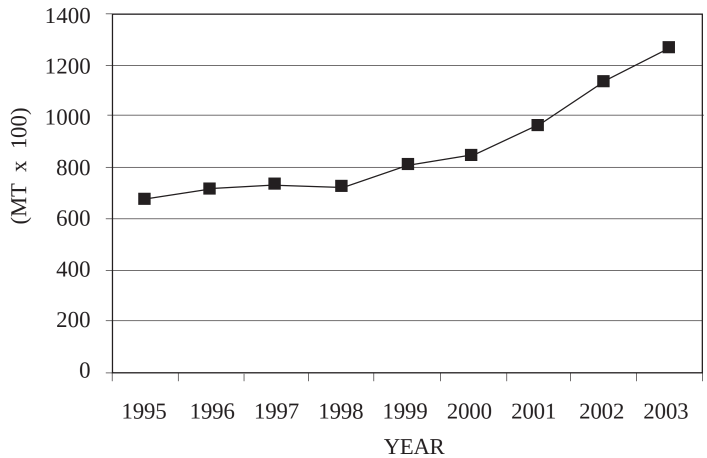

Figure 5. Trends in the Export of Prepared Fruit and Vegetables from the Asia-Pacific Region during the Period 1995–2003

CHALLENGES AND IMPEDIMENTS

From the fore-going discussion, it is clear that horticultural chain management in the region is the primary responsibility of private sector entities which are supported and facilitated by Governments. Poor quality produce due to inadequate and/or inappropriate infrastructure for postharvest handling, processing and marketing as well as inadequate levels of skills in harvesting, postharvest handling, logistics, and marketing constrain horticultural chain management and thus negatively impact on the quality and competitiveness of fruits and vegetables across the region. Furthermore, lack of economies of scale, inconsistency of supply, safety concerns and limited skills in cold chain management pose particular challenges to competitively meeting the volume and quality requirements of modern marketing systems and export markets. At the same time, fresh fruits and vegetables must be accessible to the large populations in local markets, who generally have low purchasing power.

Overcoming these challenges will necessitate:

- Increased investment in research, development, training and extension programs across the region in order to build capacity in horticultural chain management and marketing

- A macro-economic and policy environment that is supportive of development of the fruit and vegetable sector
- Proper regulatory frameworks which govern horticultural chain management and the quality of fresh produce
- Institutions and appropriate capacity to facilitate the implementation of these frameworks.
- Improved organization of farmers and farming systems
- Increased access of small farmers and processors to credit and market information

NEW ROLE OF GOVERNMENTS

The current market orientation of the postharvest sector necessitate that governments put in place institutional support mechanisms in order to facilitate farmers and the private sector in enhancing the competitiveness of the fresh produce and value-added products that they produce and market. In this regard, Governments must articulate a long term vision and strategy for development of the fruit and vegetable sector. This strategy must integrate consideration for all elements of the supply chain of fruits and vegetables, from the producer to the consumer in local, national, regional and international markets, in order to ensure that production is linked to market demand, thereby facilitating and supporting private sector linkages to new market opportunities.

Within the context of a national vision and strategy, Governments must provide a facilitating policy environment as well as incentives for investment in postharvest and value addition to fruits and vegetables. Such incentives should include support for the development of skills in postharvest management, logistics, marketing and value-addition; support for research and development; the provision of technical assistance; the provision of direct subsidies for private sector investment in postharvest specific infrastructure and the provision of credit that is responsive to the needs of producers and processors.

Since much of the production takes place in the rural sector, emphasis must be placed on fostering agri-business development in rural areas. In this regard, governments must also invest in the development of agri-business networks in rural areas.

Governments across the region are increasingly being required to provide legal and regulatory frameworks which govern horticultural chain management and fruit and vegetable quality and safety. Assuring adherence to and enforcement of the principles promoted through these frameworks will, however, necessitate that governments provide the necessary support mechanisms to the sector. Such mechanisms include ensuring the availability of support facilities such as laboratories, quality assurance and quality control services.

Given the current shift in marketing trends in the region, governments will be increasingly required to support and strengthen small and marginal farmers, who produce and sell to wet markets, so as to ensure that they are not marginaliszed with changes in fruit and vegetable marketing systems. This must be done by providing them with training, addressing their technical constraints and building institutions that respond to their needs. At the same time, it will be necessary for governments to upgrade the infrastructural facilities used by them for marketing their fresh produce, so as to ensure that these outlets remain competitive as sales outlets for fresh fruits and vegetables.

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3. PROCESSING OF FRUITS AND VEGETABLES FOR REDUCING POSTHARVEST LOSSES AND ADDING VALUE

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INTRODUCTION

The fruit and vegetable sector has grown substantially both in volume and in variety of outputs traded globally. Rising incomes, falling transportation costs, improved technologies and evolving international agreements, have all contributed to this level of growth. This increased level of fruit and vegetable production has, unfortunately, not been matched by developments in supply chain management, or by vertical integration of production with processing in many developing countries.

Processing activities are of critical importance to expansion and diversification within the fruit and vegetable sector in that they increase market opportunities for fresh fruits and vegetables and add value while minimizing postharvest losses. Furthermore, processing improves the viability, profitability and sustainability of fruit and vegetable production systems by increasing farm incomes, and generating rural employment and foreign exchange.

Traditional processing technologies such as thermal processing (bottling and canning), freezing, dehydration (salting, brining and candying) drying, and fermentation are widely applied in the processing of fruits and vegetables at various levels (artisanal, intermediate and high) and scales (cottage, small, medium and large). Tropical juices and fruit pulps, canned pineapples, tomato paste and canned and dried mushrooms are examples of fruit and vegetable products produced using traditional processing technologies and which are increasingly entering in international trade. Dried and canned mushrooms produced in China, currently account for 52% of world trade in processed mushrooms, while canned pineapples produced in Thailand accounts for approximately 45% of that product in world trade.

Minimal processing technologies, specialized packaging and natural preservation systems are increasingly being applied in the preservation of fruits and vegetables for both developed and developing country markets, in response to growing consumer demand for convenience and for “fresh-like” fruits of high quality which are nutritious, flavorful and stable. These processing technologies focus on adding value with comparatively little product transformation while increasing product diversity.

While minimal and traditional processing technologies present considerable opportunities for innovation and vertical diversification in the fruit and vegetable sector, relatively few small and medium enterprises (SMEs) are able to tap into and benefit from these opportunities. Many SMEs lack the capacity to operate competitively in the current globalized market environment owing to problems of scale, the poor quality of input supplies, poor access to technology, limited technical expertise and research capacity, low production efficiency, high marketing cost, lack of knowledge and consequently inability to comply with international standards for processed products.

After a review of cost-effective traditional and modern fruit and vegetable processing technologies appropriate to developing countries, this paper will discuss issues and constraints to improving the management of processing operations, and will highlight strategies to overcome these constraints, while citing successful case studies.

TRADITIONAL FOOD PROCESSING TECHNOLOGIES

Traditional processing technologies, applied in the conservation of horticultural produce employ a gradient of technologies, ranging from artisanal to intermediate to high technologies. Major categories of processed products produced with the use of these technologies include fruit preserves, fruit and vegetable juices, fermented products (wines and vinegars), candied products and frozen and dried products. Figures 1 and 2 summarize the major categories of traditionally processed fruit products produced in the Asian region in 2003.

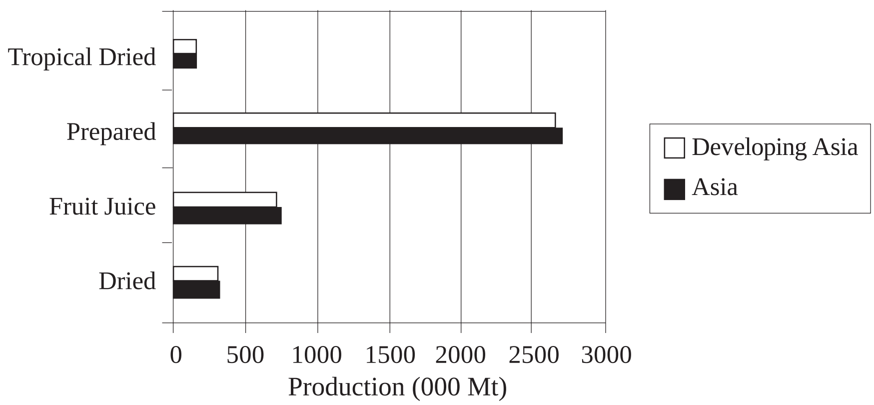

Figure 1. Major Categories of Processed Fruit Products Produced in the Asian Region in 2003 (*Source*: FAOSTAT)

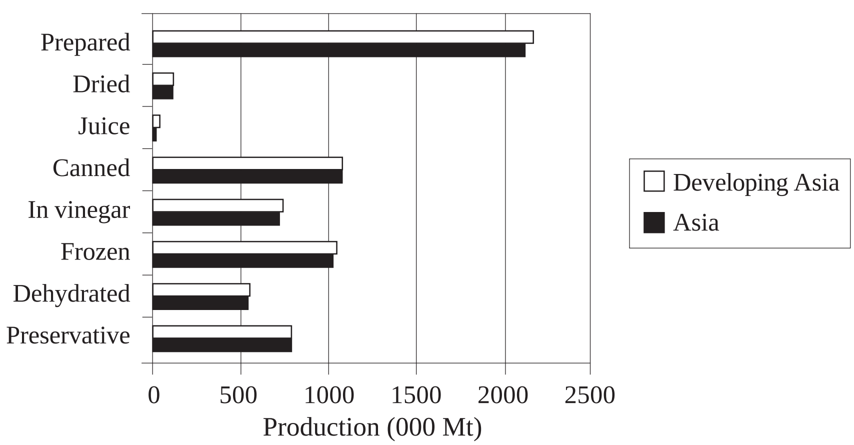

Figure 2. Categories and Quantities of Processed Vegetable Products Produced in the Asian Region in 2003

(*Source*: FAOSTAT)

While these processing technologies are generally effective in rendering fruits and vegetables microbiologically stable, they alter the flavor, color and texture characteristics of the product.

Freezing

Freezing is a fairly widespread technology which when properly carried out causes minimal changes in the shape, texture, flavor and color of foods. Vegetables are generally frozen subsequent to a blanching step, while fruit can be frozen either in a fresh state or in syrup. Many fruits and vegetables will retain good quality for up to 12 months, when stored at temperatures of -18^{0}C. The keeping quality of frozen products is, however, dependent on their storage conditions.

Energy requirements for freezing operations are high and thus the cost of this technology and the storage of its products are high. China is by far the largest producer of frozen vegetables in the region.

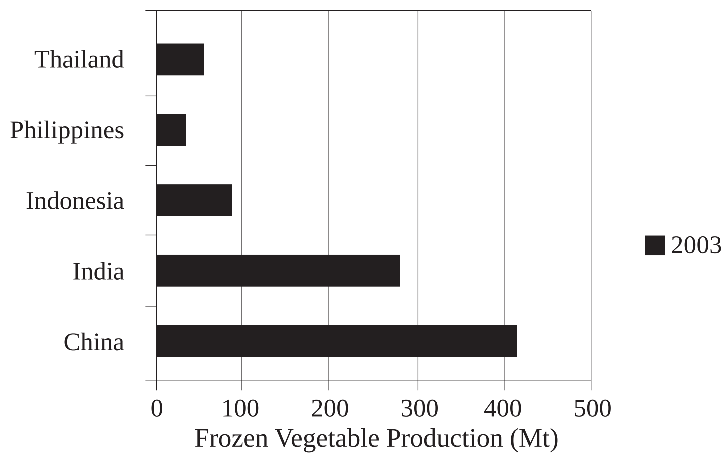

Figure 3. Frozen Vegetable Production in Developing Asian Countries (2003)
(*Source:* FAOSTAT)

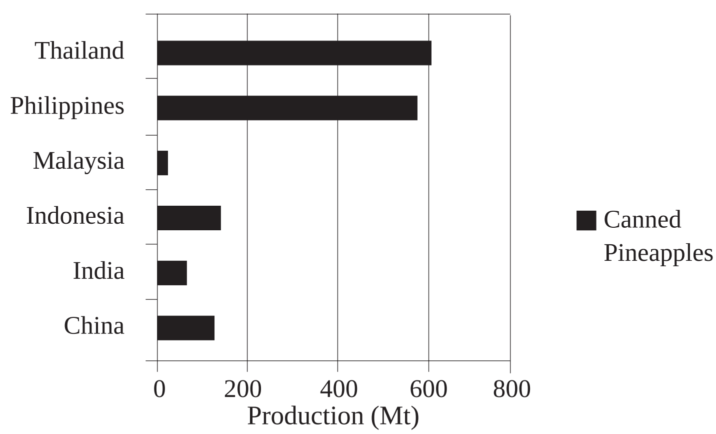

Figure 4. Leading Producers of Canned Pineapple in Developing Asia in 2003
(*Source:* FAOSTAT)

Thermal Processing

Thermal processing is still the major technology applied in the shelf-stable preservation of fruits and vegetables. Thermal processing can be carried out at a range of technical levels, from the cottage through to the industrial level, and is widely applied in the production of jams, jellies and canned and bottled fruits and vegetables. Recent developments in thermal processing technologies include the use of aseptic processing systems which make use of sterile laminated packaging. While these developments have improved product quality, they have increased product price. Leading producers of canned pineapples in developing Asia are presented in Figure 4.

Drying Technologies

Drying technologies applied in fruit and vegetable preservation range from simple and appropriate technologies such as sun and solar drying to state of the art technologies such as freeze drying, drum drying and spray drying. Dried fruit and vegetable products have the advantage of reduced weight and reduced transportation cost.

Many of the conventional drying techniques applied in the preservation of fruits and vegetables lead to losses in nutritional value, color, flavor, aroma and texture. A considerable volume of research is therefore currently focused on the development of alternative drying technologies which are economic in use and which retain product quality. Thailand is by far the largest producer of dried fruit in the region, while China is the sole producer of dried vegetables (Figure 5).

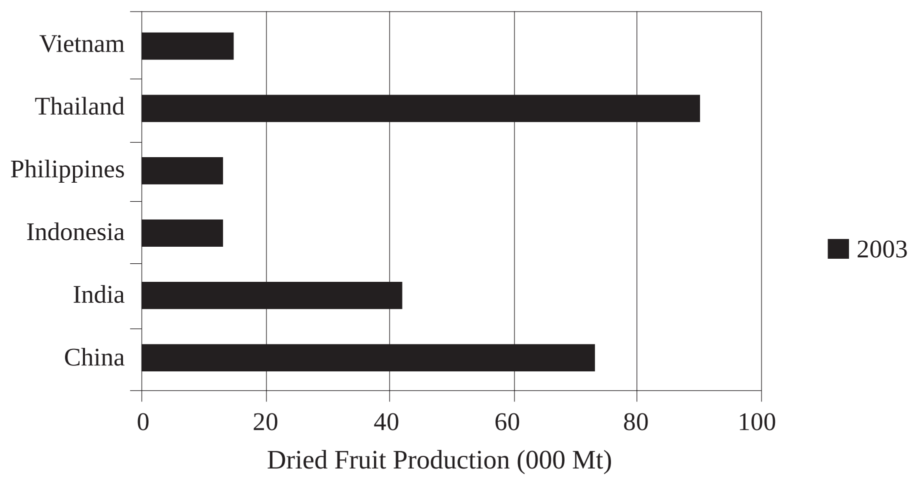

Figure 5. Leading Producers of Dried Fruit in Developing Asia (2003)
(*Source*: FAOSTAT)

Dehydration Treatments

Salting, and brining of fruits and vegetables, and the candying of fruit are dehydration treatments based on the principle of osmosis. These processes essentially involve introducing the fruit or vegetable into an aqueous solution of increased osmotic pressure (i.e., high sugar or salt content) whereby its tissue is impregnated with the solute.

Dehydration treatments of this type facilitate the removal of water, with limited exposure to heat, and can thus be applied in combination with other technologies such as drying and freezing (Figure 6), to reduce cost (Behsnilian et al., 2003). When combined with refrigeration, these treatments increase the shelf-life of fruits and vegetables over that of fresh produce.

Vacuum impregnation technology, which involves combining osmotic treatment with vacuum conditions, has been shown to improve both the texture and appearance of osmotically treated fruits and vegetables.

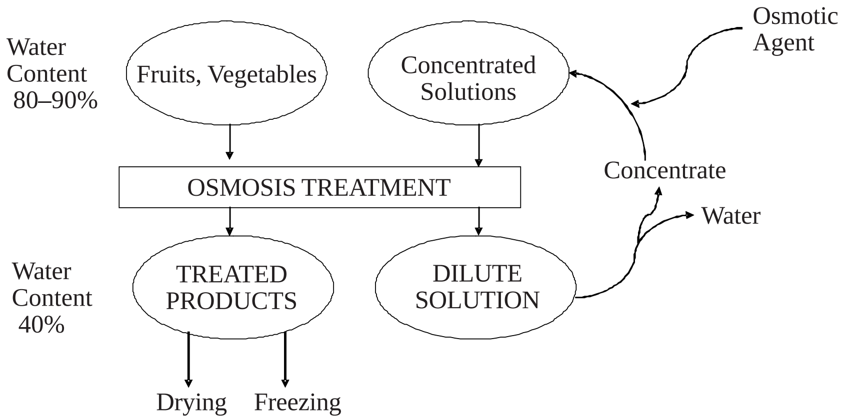

Figure 6. Osmotic Treatment as a Component Step of the Process Chain
(*Source*: Behsnilian et al., 2003)

Fermentation

Fermentation is the slow bioconservation process of foods induced by microorganisms, or by enzymes of microbial, plant or animal origin. It is one of the oldest forms of food preservation/processing technologies in the world. Fermentation technologies in developing countries have evolved through years of experience rather than through scientific breakthroughs. A variety of fruits and vegetables are preserved by fermentation (Table 1).

Table 1. Fermented Fruit and Vegetable Products Produced in the Asian Region

Name and region Type of product	
Indian sub-continent Acar, Achar, Tandal achar, Garam nimboo achar Lemon pickle, lime pickle, mango pickle Gundruk	Pickled fruit and vegetables Fermented dried vegetables
South East Asia Asinan, Burong mangga, Dalok, Jeruk, Kiam-chai, Kiam-cheyi, Kong-chai, Naw-mai-dong, Pak-siam-dong, Paw-tsay, Phak-dong, Phonlami-dong, Sajur asin, Sambal tempo-jak, Santol, Si-sek-chai, Sunki, Tang-chai, Tempoyak	Pickled fruit and vegetables
East Asia Bossam-kimchi, Chonggak-kimchi, Dan moogi, Dongchimi, Kachdoo kigctuki, Kimchi, Mootsanji, Muchung-kimchi, Oigee, Oiji, Oiso baegi, Tongaechu-kimchi, Tongkimchi, Totkal kimchi Cha-tsái, Hiroshimana, Jangagee, Nara snkei, Narazuke, Nozawana, Nukamiso-zuke, Omizuke, Pow tsai, Reid in snow, Seokbakji, shiozuke, Szechwan cabbage, Tai-tan tsoi, Takana, Takuan, Tsa Tzai, Tsu, Umeboshi, Wasabi-Zuke, Yen tsai	Fermented in brine Pickled fruit and vegetables

Many fermented products are of limited shelf-life owing to the unavailability of appropriate post-fermentation treatments which terminate the fermentation processes and extend the shelf-life of these products.

MODERN FRUIT AND VEGETABLE PROCESSING TECHNOLOGIES

Growing consumer demand for convenience and for safe foods of high quality with "fresh-like attributes," has led to considerable innovation and diversification in fruit and vegetable processing. New product lines which include high care products such as trimmed and packed beans, ready prepared salads, pre-prepared stir fry mixes and prepared fruits are increasingly entering in supermarkets in developing countries and in export trade. While value-addition of this type generally requires relatively little product transformation, it necessitates investment in technology, equipment, management systems, and stringent adherence to food safety principles and practices if product quality is to be ensured. Leading producers of minimally processed fruits and vegetables in developing Asia are shown in Figure 6.

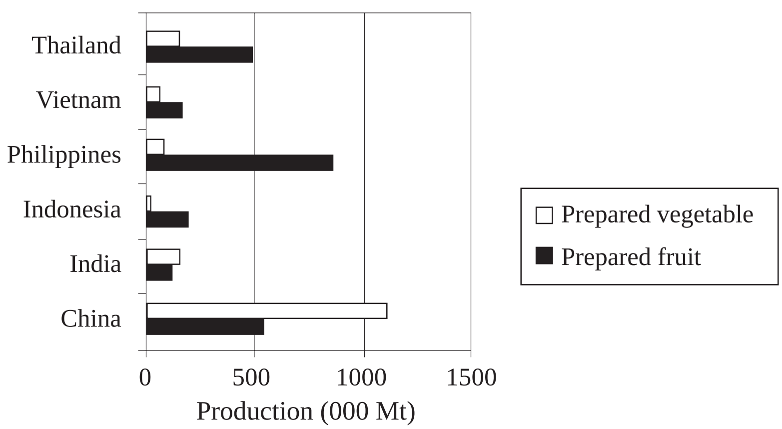

Figure 6. Leading Producers of Minimally Processed Fruits and Vegetables in Developing Asia in 2003

(*Source*: FAOSTAT)

Minimal Processing

Minimal processing employs an integrated approach wherein the handling, processing, packaging and distribution of raw fruits and vegetables is properly managed with the application of appropriate food safety principles of Good Manufacturing Practices (GMP) and Hazard Analysis and Critical Control Point (HACCP).

A hurdle approach is often applied in order to enhance the microbial stability and sensory quality of minimally processed products. The basic principle of this approach being that microorganisms are inhibited by combined preservative factors (referred to as hurdles). Low temperature storage, mild heat treatments, control of water activity, control of redox potential through appropriate packaging, the application of preservatives such as sorbate, benzoate, and ascorbic acid are commonly applied hurdles in the minimal processing for fruits and vegetables. Figure 7 depicts an example of the hurdle concept as applied to a minimally processed refrigerated product, wherein mild heat treatment, a chemical preservative, packaging and refrigerated conditions render the product storable.

Water of an appropriate quality and cold storage during the processing, packaging, distribution and retailing are key requirements of minimal processing operations.

Minimal processing applications which employ the hurdle concept are generally inexpensive, energy efficient, simple and satisfactory for the *in situ* preservation of fruits and vegetables.

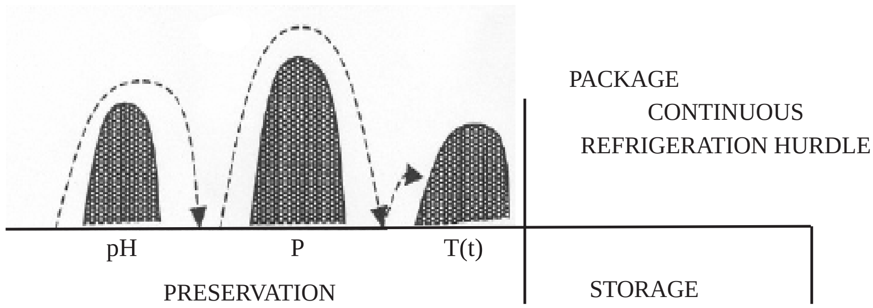

Figure 7. Schematic Representations of Hurdles: pH, preservatives (P) and Mild Heat Treatment T(t) Applied to a Minimally Processed Fruit under Refrigerated Conditions (Tapia et al., 1996, as reported by Barbosa et al., 2003)

Non-Thermal Processing Technologies

A number of non-thermal physical processes such as high intensity pulsed electric fields, high intensity pulsed light, high hydrostatic pressure and food irradiation offer considerable potential for future use in the minimal processing of fruits and vegetables. The high cost of many of these technologies precludes their application in many developing countries.

ISSUES AND CONSTRAINTS FACED BY PROCESSING OPERATIONS

Increasing urbanization and the opening of access to world markets under globalization has raised the demand for storage, quality, convenience and safety characteristics of processed fruit and vegetable products. Meeting these criteria poses a major challenge for SMEs engaged in fruit and vegetable processing. Many of these enterprises are unable to comply with international standards of Good Manufacturing Practice (GMP), HACCP certification, quality assurance, and labelling, packaging and environmental standards owing to a number of technical, infrastructural and institutional factors.

Technical Issues

Some of the technical factors which negatively impact on fruit and vegetable processing operations in SMEs include:

- Inappropriate and/or obsolete processing equipment
- Low processing efficiency
- Lack of technical support services
- Difficulty in sourcing equipment of an appropriate scale, and suited to the fruit and vegetable varieties produced
- Inadequate quality control systems

Institutional Issues

These technical constraints are compounded by a number of institutional constraints. In addition to an inadequacy of government policies which promote and support fruit and vegetable food processing, these include inconsistent and insufficient supplies of raw materials of high quality, limited infrastructure, limited access to external inputs and limited marketing infrastructure.

Raw Materials and Infrastructure

Agricultural production in most developing countries is seasonal and variable. Raw materials are often produced on a small scale for subsistence, rather than for commercial purposes, and are thus not often the best suited raw materials for processing. The procurement of consistent supplies of raw materials for processing consequently poses difficulty. The bulkiness and high perishability of fruits and vegetables, coupled with high transportation costs, underdeveloped road infrastructure and the unavailability of cool storage facilities, generally leads to considerable losses during transport from farm to the processing site, and increases the cost of inputs.

Other basic infrastructural facilities such as clean water and reliable energy supplies, which are necessary for the development of any food processing industry, are not always accessible and available.

Access to External Inputs

Relatively little attention is given to the food processing sector by planners and policy makers in many developing countries. The capacity for innovation within the industry is limited by the lack of support for research and development. University, national and regional laboratories are generally poorly equipped, and the research conducted by these institutions is often poorly linked to processing activities. Lack of information and networking pose a major hindrance to research and development.

Operational business and marketing skills are often very limited and basic knowledge on international standards of Good Manufacturing Practice (GMP), HACCP, quality assurance, labelling, packaging and environmental standards is very weak. Training programs for upgrading these skills are generally very limited and are offered on a sporadic basis with little potential for continuity and follow-up support.

SMEs generally have little economic power, are usually incapable of supporting research and often do not have the resources required to seek technical assistance. Often they are reliant on extension services which are inadequate both in training and in availability. Poor access to credit and high interest rates, often limit their ability to invest in equipment and to acquire consumable items.

Marketing Infrastructure and Marketing Systems

Limited availability of transportation and road networks, pose problems in accessing raw materials and in marketing processed products. Poor quality and packaging, and the lack of market research geared toward product improvement considerably reduce the competitiveness of processed products in local markets. The incapacity to adhere to the stringent quality standards and labelling requirements and the lack of economies of scale also poses a major barrier to accessing foreign markets.

STRATEGIES TO ADDRESS CONSTRAINTS TO FRUIT AND VEGETABLE PROCESSING

Enhancing the competitiveness of SMEs in fruit and vegetable processing will necessitate strategies designed to upgrade raw material supplies, increase processing efficiency, develop economies of scale and upgrade technical and management skills.

Upgrading Raw Material Supplies

The fruit and vegetable processing sector is highly dependent on the quality of its raw material inputs. Raw material quality is related to the variety, as well as to the harvesting techniques, postharvest handling, storage and transportation of fresh produce. Attention must therefore be paid to the selection of appropriate varieties for processing. Good Agricultural Practices (GAP) must be promoted in the production of raw materials, and traceability must be assured throughout the value chain.

Strengthening grower-processor linkages through well organized postharvest handling chains can contribute tremendously to improving the volume and quality of raw materials, while ensuring traceability at the production end of fruit and vegetable value chains. Mechanisms such as contract farming and cooperative arrangements can provide strategic advantages in obtaining planting material of the appropriate quality in appropriate quantities (Box 1).

Box 1

Grower-Producer Linkages in the Philippines

An FAO Project entitled Technical Support to Agrarian Reform and Rural Development, developed a series of coordinate programs that led to the promotion of linkages between small-farmers and food processing enterprises.

The small farmers were new owners of land transferred under the Comprehensive Agrarian Reform Program (CARP). The farmers were not effectively linked with the market and had limited technical and financial resources. On the other side were agri-business firms that needed a reliable source of raw materials and partners who could meet industry requirements in terms of quality, quantity and timely delivery.

The Department concerned with agrarian reform placed high priority in promoting linkages between the farmer organizations and processing enterprises. A production-processing linkage based on mutual benefit therefore resulted. Farmers, through their organization, supplied raw materials to food processors, who in turn provided the steady market that offered a fair price.

Linkage instruments used were:

- Memorandum of understanding (MOU)
- Memorandum of agreement (MOA)
- Letters of intent by the buyer to indicate his desire to purchase farmer produce

Increasing Processing Efficiency

Improving efficiency, quality and safety in fruit and vegetable processing, calls for considerable investments in processing infrastructure as well as for skilled technical expertise. Research and development is also required for the adaptation of technologies to the type/variety of raw materials produced, to agro-climatic conditions and available infrastructure.

Meeting these criteria necessitates those SMEs either organize themselves into cooperative entities whereby they can gain efficiency and share research and development expenses or enter into partnerships with foreign firms that could extend both finance and know-how. Formal and informal networking among SMEs, with technical centres and research organizations can also enhance information flow and exchange of ideas and technologies. Clustering of SMEs can, also facilitate learning with partners and improve access to skills and resources.

The design of logistical arrangements which optimize the use of existing infrastructure will assist in reducing costs and losses in fruits and vegetables. The partial processing of products at the field level for example would tremendously minimize losses and would reduce bulk in transportation from rural areas to major processing sites.

Development of Technical and Management Skills at the Enterprise Level

Keeping abreast of market developments, trends, new processes and equipment is very critical to maintaining competitiveness in the fruit and vegetable sector. It is therefore imperative that SMEs invest in capacity building in managerial skills. Technical personnel must, likewise, be properly trained and their skills periodically upgraded so as to facilitate their application of best practices in line with current international standards of good manufacturing practices and HACCP.

Developing Strategic Alliances

The formation of strategic alliances can assist SMES in achieving economies of scale and in benefiting from strategic advantages in the acquisition of processing inputs, in designing packaging materials which meet the requirements of diverse markets, as well as in overcoming the high cost of developing and maintaining a market presence. By engaging in joint ventures with Japanese buyers, Thai firms have for example increased their ability to meet stringent quality requirements of the Japanese market, and have also become dependent on their partners for marketing and distribution (Nikomboriak, 2003).

Support Services

Government investment in the form of, infrastructural and institutional support to SMEs is also vital to overcoming many of the technical and institutional constraints. Support to the sector through the provision of training in order to upgrade skills is required. Policies designed to support and stimulate small-holder investment in the fruit and vegetable processing sector, e.g., those which facilitate access to credit and provide tax incentives for SMEs and which support partnerships and strategic alliances are pivotal (Box 2).

Box 2

The Case of the Pork and Poultry Processing Cluster in Brazil

Contract farms in the Santa Catarina State of Brazil are involved in animal production, with inputs from the processing companies. Processing companies supply: animal stock, feed, technological advice, and quality control. The know-how which evolved from pig raising was successfully transferred to poultry raising, and poultry processing. Pork is produced primarily for the local market, while poultry is exported. Larger firms in the meat cluster have diversified into other foods such as vegetable oils and fruit juices.

Several factors have contributed to the success of this cluster.

- Situation of the processing concerns in a dynamic environment which supported the diversification into new products, adaptation of new technologies, and the opening of new markets.
- Promotion of economic development in the region by industrial support organizations
- The provision of training, and upgrading of skills by the state. Infrastructure and other support institutions (e.g., warehouse cooperatives) are also promoted.

(*Source:* Information provided by Secretaria de Estado do Desenvolvimento Economico e Intgracao ao Mercosul, and FIESC Florianopolis, Brazil as reported in UNCTAD, 1997.)

CONCLUSIONS

Tremendous opportunity exists for vertical diversification within the fruit and vegetable sector through the application of both modern and traditional processing technologies. Taking advantage of these opportunities will necessitate that stronger backward linkages be developed with the production sector, and that strategic alliances be developed and fostered so as to upgrade technologies and skills, as well as to increase product competitiveness. Supportive government policies are pivotal.

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4. PACKAGING AND TRANSPORTATION OF FRUITS AND VEGETABLES FOR BETTER MARKETING

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INTRODUCTION

Fresh fruits and vegetables are highly perishable. Farmers take care of their produce from seedling to harvest and therefore expect good returns. Postharvest losses which average between 24 and 40% in developing countries, and between 2 and 20% in developed countries are a major source of waste. High levels of waste result in higher prices for fresh produce, and the farmer increasingly facing poverty.

Fruits and vegetables are generally produced by farmers for their families and for nearby markets. Farmers at the SME level, however, generate income by growing fruits and vegetables for local and distant markets. Appropriate preharvest practices, proper postharvest handling, packaging and transportation are, therefore, critical to maximizing returns to these small commercial farmers. Marketing must also be well planned.

Fresh produce after harvest can be considered as being in a live form, as it continues the process of respiration and transpiration until its reserves of food and water are exhausted. Physiological changes or the rate of deterioration of fresh produce is influenced by the temperature, composition of the air surrounding the produce, and the humidity of the environment. No matter how good the quality, if packaging, transportation and marketing are not properly taken care of; fresh produce will be damaged and will undergo rapid decay. The causes of losses in fresh produce vary widely.

This paper will discuss how packaging and transportation of fruits and vegetables can reduce postharvest losses and improve marketing.

PACKAGING

Fresh fruits and vegetables are generally packed in bamboo baskets, plastic crates, plastic bags, or nylon sacks for transportation, in many developing countries. Often, they are transported in an unpackaged form. After harvest, fresh fruits and vegetables are generally transported from the farm to either a packing house or distribution center. Farmers sell their produce either in fresh markets or in wholesale markets. At the retail level, fresh produce is sold in an unpackaged form, or is tied in bundles. This type of market handling of fresh produce greatly reduces its shelf life if it is not sold quickly. The application of proper postharvest technologies, would, however, extend postharvest shelf life, retain fresh quality and reduce losses.

Packaging plays a very important role in protecting fresh produce:

- It provides protection from dust;
- It reduces microbial contamination from the surrounding environment and from consumer contact;

- It helps to maintain the freshness of produce;
- It extends the postharvest shelf life;
- It increases the sale of fresh produce.

The development of packaging which is suited to the handling of fresh produce necessitates an understanding of the physiological characteristics of the produce. Fruits and vegetables may be characterized as being either climacteric or non-climacteric, depending on their respiratory pattern:

- *Non-climacteric fruit* ripen only while still attached to the parent plant. Their eating quality suffers if they are harvested before they are fully ripe because their sugar and acid contents do not increase further. Their respiration rate gradually declines during growth and after harvesting. Maturation and ripening are a gradual process. Examples of climacteric fruit include: cherries, cucumbers, grapes, lemons and pineapples.
- *Climacteric fruit* can be harvested when mature but before the onset of ripening. These fruits may undergo either natural or artificial ripening. The onset of ripening is accompanied by a rapid rise in respiration rate, generally referred to as the respiratory climacteric. After the climacteric, the respiration rate slows down as the fruit ripens and develops good eating quality. Examples of climacteric fruit include: apples, bananas, melons, papaya and tomatoes.

Ethylene gas is a plant hormone which initiates senescence or ripening. It is active in very small amounts at 0.1 ppm. Ethylene action and binding to the receptor site is impeded by oxygen levels of less than 8%.

Fresh produce is generally packed in plastic crates, plastic bags or corrugated paper boxes in Thailand. Corrugated paper boxes are used for the packaging of fixed counts of uniformly sized produce such as avocadoes, mangoes and oranges. Boxes protect the commodity by cushioning and immobilizing it. They are easily handled throughout distribution and marketing, and can minimize the impact of rough handling. Boxes should serve as a moisture barrier and should be designed with appropriate ventilation capacity. Corrugated paper boxes cannot, however, significantly extend shelf life even when used for the low temperature storage of fresh produce.

Much of the plastic material used in the bagging of fresh produce, is unsuitable owing to poor moisture and gas permeability. This often leads to condensation, high CO_2 and low O_2 levels in bagged produce, and results in flavor deterioration and fermentation or failure of the fruit to ripen. Thus use of plastic packaging designed for the marketing of fresh produce should incorporate consideration for factors such as: O_2 uptake, CO_2 production, and the production of heat and ethylene by the produce.

Low density polyethylene film is generally used for the packaging of fresh fruits and vegetables, owing to its high permeability and softness when compared to high density film. Polyethylene can be easily sealed, has good O_2 and CO_2 permeabilities, low temp durability, and good tear resistance and is of a good appearance. This film is therefore used for the production of modified atmosphere packaging (MAP) which can be manipulated to match the characteristic respiration of produce, by: reducing O_2 levels in order to slow down the respiration rate, metabolic rate, and senescence of the produce.

Effective O_2 levels must be maintained at between 2% and 10% in MAP systems, if fermentation of the produce is to be prevented. Elevated CO_2 levels reduce the sensitivity of fresh produce to ethylene, and slow down the loss of chlorophyll. At CO_2 levels ranging between 1% and 5%, however, fruit fail to ripen, internal breakdown occurs and off flavor development ensues. Oxygen and carbon dioxide transmission rates for MAP films should, therefore, match the respiration rate of the produce to be stored.

MAP is very effective in retaining freshness, and for extending the shelf life of fresh fruit and vegetables. MAP is also ideal for the marketing of minimally processed produce, such as mixed salads, fruit salads and fresh cut produce. This type of package is designed to exactly match the handling conditions and respiration rates of specifically packaged produce, by manipulating O_2 and CO_2 levels in the packages, so as to:

- Maintain the green color of leafy vegetables;
- Reduce loss due to the production of respiratory heat by produce;
- Maintain the natural fresh taste of produce;
- Extend the shelf life;
- Delay ripening.

In some instances, MAP films are impregnated with minerals, in order to absorb and remove ethylene produced in the storage environment around the bagged produce. Impregnated MAP films are particularly suitable for transporting bulk fresh fruit and vegetables to distant markets or between farmers and consumers at supermarkets and retail outlets. The produce must, however, be properly handled and packaged prior to transport.

Recent successes in the use of MAP for reducing postharvest losses in fresh fruits and vegetables are as follows:

Broccoli	*Normal Storage* 3–5 days after harvesting the flowers change from green to yellow. *MAP and storage at* 4–7°*C* Shelf life of 14 days, the fresh green flowers and crispness are retained.
Parsley	*Normal Storage* Shelf life: 3–5 days *MAP and storage at 1–2°C* Shelf life of up to 25 days, and retains fresh green color
Banana	*Normal Storage* Shelf life of 5–7 days *MAP and storage at 13–14°C* Shelf life of up to 45 days
Green bean	*Normal Storage* Shelf life of 3–7 days *MAP and storage at 5–7°C* Shelf life up to 16 days

Advantages of MAP

- Extends shelf life
- Prevents dehydration
- Retains green color and prevents yellowing
- Preserves fresh taste and aroma
- Delays ripening
- Prevents fungal and bacterial growth
- Increases the sale of fresh produce

TRANSPORTATION

Fresh produce is primarily transported by road, from farmer to consumer. A marketing concern is that fresh produce should be of the highest quality and should be kept in the best condition during transportation. Minimizing losses during transportation, necessitates that special attention be given to vehicles, equipment, infrastructure and handling. Fresh produce is transported using both refrigerated and non-refrigerated vehicles.

Non-refrigerated vehicles are generally open-sided trucks, with wire mesh frames. This type of transportation is inexpensive, convenient and easy. Truck can be used for the delivery of fresh produce, other goods and passengers when required. Layers of produce are not, however, separated in order prevent heat generation. Often the produce is stacked too high.

Non-refrigerated vehicles are used for transporting produce over distances of up to 850 km. On arrival the produce must be unloaded or sold as quickly as possible to overcome overheating. Fresh produce must not be watered prior loading, as this will lead to decay, rotting and extensive losses.

Major causes of losses during the non refrigerated transportation of fresh produce, are:

- Improper handling during loading and unloading
- Over loading without separation of produce which leads to overheating and mechanical injury to produce at the bottom of the stack
- Rough roads
- Lack of ventilation of the produce

Refrigerated Vehicles

Fresh fruits and vegetables are increasingly demanded in international markets. Meeting the requirements of these international markets, presents a considerable challenge to the postharvest handling of fresh produce. Packaging plays a major role in meeting this challenge.

Modified atmosphere (MA) packaging and controlled atmosphere (CA) packaging can be used for different fruit and vegetables. MAP creates a steady atmosphere of O_2 and CO_2 around the produce within the MAP package, while CA provides an optimum atmosphere of oxygen and carbon dioxide around the packaged produce. MAP has been developed to match specific produce requirements, and can be combined with CA storage. Moreover, mixed produce can be loaded by design systems in which some MAP material is impregnated with minerals in order to absorb and remove ethylene production. The mixed produce should be compatible with respect to their level of ethylene production. Temperatures should also be maintained at an optimal level during transportation.

Recently MAP packaged produce has been transported in CA containers at suitable temperatures and relative humidities. These systems have resulted in extending shelf life, retaining fresh produce quality and reducing losses. However, the problem of moisture condensation within the MAP bags still arises. New packaging innovations designed to control this, include condensation control packaging (CCP) and compact controlled atmosphere packaging (CCAP).

The following are examples of situations where MAP packaged fruit are transported at low temperatures in CA storage systems:

Mangoes (ripe)	Stored in CA of 3–5% O_2 and 5–8% CO_2 at 10°C. Shelf life extended up to 20 days, when compared to 5–7 days for control fruit.

Broccoli	Stored in CA of < 1% O_2 and 10% CO_2 at 1–2°C. Shelf life extended up to 25 days when compared to 3–5 days after harvest. Produce retains fresh green florets and crispness.
Basil	Stored in CA of 1–5% O_2 and 5–15% CO_2, at 0–5°C. Shelf life extended up to 25 days when compared to 3–4 days.

Advantages of MAP Packaged Produce in CA Storage

- Quality of internal & external color and flesh maintained;
- Reduced chilling injury;
- Delayed ripening and senescence;
- Texture of fruit maintained;
- Shelf life, of fruit increased, and the frequency of delivery reduced;
- Reduced decay and weight loss.

PACKAGING FOR BETTER MARKETING

Marketing is a very important element of any business venture. Different levels of risks are taken, depending on the product and efficiency of marketing management. In the case of ceramics for example, the product can be stored if it cannot be marketed. Fresh fruits and vegetables, on the other hand, cannot be kept unless they are preserved. Given consumer preference for fresh produce, greater cooperation is required among farmers and distributors or retail outlets, if quality is to be ensured. Improved marketing can be achieved through the development of marketing strategies, evaluation of the efficiency of marketing operations, as well as through internal and external marketing management. Those who market the produce must understand consumer buying behavior so as to ensure consumer satisfaction. Proper packaging will help to ensure attractive, clean, fresh produce providing customer satisfaction, and resulting in a higher market share. Therefore, both the farmer and the seller should bear in mind that the consumer is the key to the achievement of marketing goals.

Packaging can be done at various stages (+p) of the postharvest chain (Please see Figure 1).

CONCLUSIONS

Packaging and transportation can be manipulated in order to reduce postharvest losses in fruits and vegetables. Packaging technology allows supermarkets to reduce their labor costs and reduce waste, while providing the consumer with a selection of fresh produce which is safe and of a high quality. Reduction of postharvest losses in fruits and vegetables and expanding markets provide benefits for the seller and the buyer, and increases farmer income and alleviates poverty.

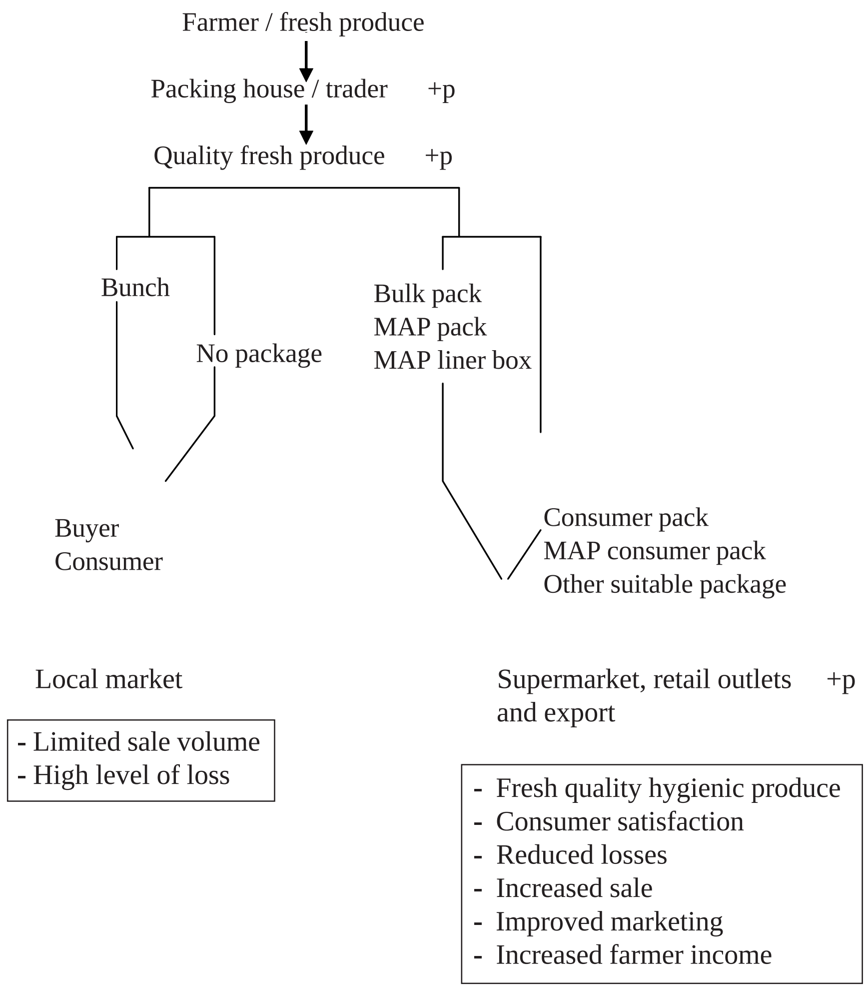

Figure 1. Packaging and Transportation of Fruits and Vegetables

5. LINKING PRODUCTION AND MARKETING OF FRUIT AND VEGETABLES FOR BETTER FARM INCOMES IN THE ASIA-PACIFIC REGION

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INTRODUCTION

There are two fundamental routes by which farmers can increase their incomes from the marketing of fruit and vegetables. With one route they can concentrate on the demand aspects. The other concentrates on the supply issues. In turn, each route has a number of parameters.

With the demand route, there are a number of options:

- Directly linking with the end buyer
- Better use of better market information
- Fixing incomes by contracting

With the supply route the basic option is to establish better economies along the supply chain.

Each will be dealt with separately.

DEMAND ORIENTED OPTIONS

Farmers need to be aware that at the end of the day they rarely deal with the end consumer of their product. Instead they deal with a large number of intermediaries.

Amongst APO member countries criticism of intermediaries is all too common. In the main, intermediaries are abused of being rapacious middlemen who make obscene profits at the expense of the either the producer, or the end consumer, or usually both. To merely measure the gap between what a "middleman" pays to the farmer and what the consumer ultimately pays at the retail level is not only naïve but is also extremely misleading causing considerable distrust amongst the various actors in the chain[1]. Globally there are countless cases of farmers who, falsely believing that the gap between what they receive and what the end consumer pays is solely profit, are enticed to enter the nether world of moving up the marketing chain themselves. That countless number is neatly matched by the number of farmers

1 For example see the following drawn from just the Indian journal *Agricultural Marketing*.
- Sharan S. P. and Singh V. K. 2002. Marketing of kinnow in Rajasthan. October–December.
- Gadre A. V. and Talathi J. M. 2002. Price spread in marketing white onion in Raigad District of Maharashtra States. October–December.
- Shaheen F. A., and Gupta S. P. 2002. Economics of apple marketing in Kashmir Province: problems and prospects. July–September.

(To be continued on the next page)

who go broke in the nether world of moving up the marketing chain. In other words the gap between what the end-consumer pays and what the farmer receives is not all profit there for the easy taking.

To be fair, there are any number of middlemen who make obscene profits off the backs of farmers. Middlemen who charge a mark up but who do not provide a reciprocating service are indeed rapacious.

However, sometimes the service is hard to physically identify. Services such as grading, packaging, coordinating and providing transportation, and providing financing are easily identified. Some are a little more difficult to identify. On an exercise of exporting vegetables from Bhutan to Bangladesh there was the need to provide eight sets of documents of six pages each. Assembling the documentation took one person a whole day whilst the project coordinator, who had post graduate qualifications from a North American university, could only sit and watch. The coordinator estimated that had he had to do the documentation himself it would have taken at least four days. Some one has to pay for that day's activity.

On the other hand, providing contacts, or even more obscure, taking risk, is much harder to identify and are thus far more susceptible to the accusation of price gauging/ profiteering.

The key to farmers increasing their incomes from the marketing of their fruit and vegetables is to identify what services a middleman provides that:

- cannot be done by someone else in an more efficient manner;
- or, cannot be reduced;
- or, cannot be done without.

Farmers need to closely look at the operations of middlemen and work with them to improve the service.

This is because it is an excessively expensive process for farmers to undertake what is called "price discovery". This is the process that identifies the following critical elements in the marketing chain:

- Grade
- Variety
- Maturity
- Packaging specifications
- Optimum logistics
- Price

Farmers traditionally send produce to the market. It usually takes several shipments before the farmer is able to establish the correct variety, the correct grade, and an appropriate price.

An excellent example of the cost to producers of price discovery is the movement of pumpkin/squash *Cucurbita maxima* from the Kingdom of Tonga to Japan. The first shipments in the late 1980s were not considered to be of the correct variety. Nevertheless, they were accepted but at a discounted price. Then the size and shape was not considered by the Japanese to be appropriate. Again, a discount was required to quit the crop. Then there was

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- Chole V. M., Talathi J. M., Naik V. G. 2003. Price spread in marketing of brinjal in Maharashtra State. July–September.
- Balappa S. R., and Hegar L. B. 2003. Economic evaluation of onion production and the marketing system in Karnataka. July–September.
- Shapoo J. A., and Banergee B. N. 2003. Economics of apple production in Anantang District of Jammu and Kashmir. July–September.

a problem with the gold spot, a problem that was solved after discounting. In each of these examples, the Tongan farmer was required to pay a hefty price for price discovery.

What makes price discovery by the farmer all the more frustrating involving pointless expenditure is the fact that the knowledge required already exists with the various middlemen along the marketing chain.

The most efficient way for farmers to learn the requirements of the markets is to engage themselves in the value chain.

VALUE CHAINS

Value chains have become the center of considerable academic, practical, and political interest. Case studies abound, writings have proliferated, and analytical tools are emerging rapidly. Particular focus has centered on the role of value chains in the developed-underdeveloped debate.

Part of the reason for the rapidly growing interest in value chains in the horticultural sector has been the result of changes in global retailing. In a large number of countries, supermarkets chains now dominate food retailing. A massive percentage of all fresh produce is now sold by the major supermarket chains. Supermarkets have increasingly integrated their operations involving many aspects of the post farm gate operations. There are increased standards of technical, environmental and social requirements. This is particularly true for horticultural produce.

Most of these conditions are related to Europe, especially the United Kingdom. In the main, few food retailing chains in Asia dominate as they do in Europe. Japan for example has arguably the most sophisticated degree of food retailing in Asia. Yet no one supermarket chain dominates more than 10% of national sales. Hong Kong and Singapore are the exceptions where the two main chains do dominate[2]. However the massive reliance in the two countries on imports tends to make the exception understandable. Western based retailers are already common in Asia and it is highly likely that they will bring their European-based management practices to the region[3]. Value chain management is one of these.

Even though value chains are Trans Atlantic in orientation, the lacks of value chains have universal applications. Five specific issues are identified from Asia[4].

- *Supply chain bottlenecks* resulting in farmers experiencing gluts of commodities, processors not being able to procure sufficient raw materials for their plants, retailers not getting sufficient products to meet the demand of consumers, and exporters are unable to meet foreign consumer requirements.
- *Lack of Innovation* that affects the entire chain, an example being the introduction of plastic crates for a fruit processor involves a vast number of actors in the chain to coordinate their efforts

2 In Park N. Shop and Welcome, and NTUC Fair Price and Cold Storage, respectively.

3 A non-complete list includes:

Jusco (Japan)	China, Japan, Hong Kong, Malaysia, Thailand
Tesco (UK)	Thailand, Rep. of Korea, Rep. of China, Malaysia, China, Japan
Delhaize (Belgium)	Thailand, Indonesia, Singapore
Wal-Mart (USA)	China, Rep. of Korea (this excludes part ownership in other retailers in other countries)
Promodes (France)	Rep. of China, Indonesia, Rep. of Korea
Auchan (France)	Thailand

(To be continued on the next page)

- *Isolated cases of success*
- *Low organizational capacity* leading to frustration in solving problems as individuals which in turn generates a perception of helplessness and induces a dependency attitude, whereby problems are expected to be solved by the Government, or by investment and technical assistance provided by donors
- *Low private investment in rural areas*

In simple terms a value chain is a series of participants along the entire marketing spectrum who collaborate to satisfy market demands for specific products or services to their joint and collective mutual benefit.

The participants in the case of, say, the Tongan pumpkin industry would be:

- Seed and associated input suppliers
- Grower
- Packer/grader
- Shipper
- Importer
- Distributor
- Retailer/food service sector

The advantages of being a participant in a value chain are:

- Reduction in the cost of doing business
- Increase in the bargaining power
- Improved access to advanced technology, information and capital
- Continual exposure to innovation creates its own momentum

Features of an effective value chain are:

- Dealing in a differentiated product and thus a product more likely to achieve a higher return to the producer
- Continuous innovation across the spectrum of product, technology, management, and distribution
- Creation of higher values
- Formation of alliances
- "Trueness to promise" that guarantees the likes of eating quality and nutrition
- Food safety with integrity and traceability
- In-store handling and presentation
- Inventory management including the quality of the inventory storage for specific food products
- Transport logistics
- Movement away from producers' spot selling to programmed selling

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Casino (France)	Rep. of China, Thailand
Costco (USA)	China, Rep. of Korea, Rep. of China
Metro (Germany)	China, India
Carrefour (France)	China, Indonesia, Japan, Singapore, Rep. of Korea, Rep. of China, Thailand, Malaysia
Makro (Germany)	Philippines

To be fair, the success of Western retailer chains in Asia has been very uneven. Many have succeeded but just as many have failed. The Dutch cash and carry chain Makro was the first foreign retailer in the Rep. of China, commencing in 1989. In 2003 it abruptly closed its six stores. Royal Ahold has similarly declined in Singapore and Malaysia.

4 Much of the next section draws on participation in the project India: Agribusiness Development Support. ADB TA No. 4407- IND. Janaury–April 2005. Willing recognition is made of the leadership in the project of Dr. Francesco Goletti, Agrifood Consulting International Inc, USA.

The above aspects will be illustrated by reference to a case study involving the Kingdom of Bhutan and India.

Case study

There are two essential pieces of background information.

First, in July 2004, Bhutan undertook a trade display of summer vegetables into Bangladesh. That display was done in cooperation with a retailer. Western style retailing with its emphasis upon chains is in its infancy in Bangladesh. The retailer that Bhutan worked with has three outlets. A critical lesson from that exercise was that whilst any given retailer is able to offer a comparatively good price, that price is only for that retailer's specifications. The retailer may be trying to service the top end of the market or the mid-market but the price is specific to the retailer's specification. Supply by the grower is limited to that retailer's demand. It is rare that the one retailer can absorb the entire range of a producer's product. This was certainly the case with Bhutan.

The lesson then was that for this stage of its export development, Bhutan would be better served by working with someone along the distribution chain that has access to a wider range of outlets. That is, a wholesaler or some other form of distributor. Bhutan was able to find a distributor that met these conditions. He had access to around 20 stands in a number of food retail outlets as well as in the food service sector, and the wholesale markets.

At the same time the distributor was looking for a supplier that could supply vegetables into Kolkata at that time of the year, that is during the hot summer months of June and July and then through the monsoons season of August and September. Because its altitude gave it the ability to grow summer vegetables at this time of the year, the distributor saw in Bhutan a solution to his summer supply problem.

Value chain theory talks of mutual dependence. This was mutual dependence par excellence: a seller looking for further markets and a buyer looking for a new source of supply.

The second is that Bhutan needed to undertake its own market research in order to establish for itself the likely demand for its targeted products at that time of the year. Whilst the value chain concept depends upon trust and the sharing of information, it does require the individual participants along the chain to know their own business. Thus Bhutan undertook a series of studies into the demand-supply situation of summer vegetables at that time of the year[5]. The details of the arrangement must be treated as commercial-in-confidence. However the following illustrates the value of partners working together in a value chain operation. Reference will be made to just the one product – tomatoes.

The initial order by the distributor did not specify what type of tomatoes. In the end, Bhutan delivered a different type to what Kolkata was used to, that is, Bhutan supplied a Roma type tomato where-as the market was more use to an egg-shaped one. Rather than outright rejecting the shipment, the distributor eased the tomato into a number of different outlets, not just the one. Whilst it moved slowly in some outlets it moved more quickly in others.

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5 *Developing the Kolkata market for Bhutanese summer products*, Grant Vinning SNV Marketing Specialist, Sonam Tobgay, Agricultural Marketing Services, Ministry of Agriculture. Thimphu. September 2004.
Market analysis of select vegetables: Kolkata. Grant Vinning, SNV Marketing Specialist, Ministry of Agriculture, Thimphu, Kingdom of Bhutan. June 2005.
Marketing vegetables in Kolkata: the view from the market place. Grant Vinning, SNV Marketing Specialist, Ministry of Agriculture, Thimphu, Kingdom of Bhutan. June 2005.

The distributor had stated that he wanted “half ripe tomatoes”. That is, a tomato that was picked at the breaking color stage in Bhutan so that after three days from picking it would be in Kolkata and then another three days of shelf life. Bhutan was unsure what was meant by “breaking color” and “half ripe”. A series of photos were taken to illustrate different stages of “half ripe”. These were then shown to the distributor. He then compared the color after four days with the different colored tomatoes in the photos. A precise definition of “half ripe” was then established. Further, the distributor was able to show what happens to tomatoes that were picked at the too-green stage and as well as the too-ripe stage. Photos were taken of these for distribution back in Bhutan. Thus growers in Bhutan have been able to learn at minimum cost what is the ideal stage at which to pick their tomatoes[6].

Initially, the tomatoes were transported from Bhutan to Kolkata by bus. Economies of scale ruled out using dedicated transport at this stage. The bus takes a particular route through Kolkata before finishing at the bus terminal. Traffic curfews in Kolkata limit severely the ability of commercial vehicles to enter the bus terminal to remove commercial cargo.

To be stored in the open in the middle of high heat of Kolkata’s summer is disastrous for the tomatoes[7]. The distributor suggested that for the payment of a small service fee the tomatoes could be offloaded at a point close to his premises. This eliminates the need to transport the tomatoes all the way into the city only to be moved back to the warehouse. In the end, close on half a day in the searing heat was saved.

As part of its market research Bhutan was keen to learn how the market accepted this different tomato variety. A visit was made to one the distributor’s retail outlets. There the distributor enlisted the cooperation of the retailer so that photos could be taken in-situ for grower education back in Bhutan. The taking of photos in stores is normally not allowed by retailers. However because of the mutual cooperation between supplier, distributor, and retailer, the photos were taken and relayed back to Bhutan.

For its part, Bhutan has to undertake a considerable extension effort with its producer to establish the correct color stage at which to harvest its tomatoes. It must also develop simple on-farm systems of postharvest preservation in order to reduce field heat. Seed suppliers have to be contacted to see if they have the varieties preferred in Kolkata.

Lessons

The development of value chains is highly rewarding to both seller and buyers. The two outstanding benefits are:

- Reduction of costs by all participants
- Sharing of innovations that enhance profits

However, achievement of the benefits of value chains requires a pro-active approach. In the main, producers have to show a far greater degree of initiative in seeking out partners in the value chain.

Participants in this Seminar are drawn nearly totally from the public sector, albeit with some from the tertiary education sector. Given that the bulk of fruit and vegetables in the 13

6 A comparable example of the provision of mutually beneficial advice related to peas. Peas are highly susceptible to break-down if their field heat is not reduced. Upon arrival at his warehouse, the distributor took the Bhutanese peas and spread them across the floor under a fan. The build up in heat was suddenly reduced, thereby extending their shelf life. The next day a bag of peas also from Bhutan were seen in the markets at Kolkata. They were kept in the bag in which they were transported to India. A quick hand feel verified their heat and their likely very short shelf life. The seller did not care as he was on a commission so he would not lose money, albeit he would have reduced profit.

7 On the first day of the trial it was 40°C and 66% R.H.

participating countries are atomistic small-holders, perhaps the initiative to instigate value chain partnerships should start with them[8].

CONTRACT FARMING

Contract farming is not a new phenomenon as it has a long history in the United States, Europe, and colonial Africa dating back to the 1930s and 1940s[9]. Nor is it necessarily new to Asia[10]. However contract farming is taking on a new perspective today in Asia. The reasons for this can be summed under two opposing schools, one related to reduce waste, the other to maximizing income.

With the waste factor, there has to be recognition that market linkages between farmers and retailers/processors are extensive and complex. Usually, for a particular product to travel from the farm gate to consumers it has to pass through many different hands. On the way it is packed, unpacked, graded, sorted, handled and transported many times. This has significant consequences not only for the quality of the product when it eventually reaches the end consumer, but also for the efficient organization of the agricultural marketing system.

A lack of linkages between non-adjacent levels of the chain perpetuates a situation where there are multiple middlemen handling the produce from farm gate to consumers, with the attendant increase in postharvest losses and financial inefficiencies from multiple handling, packaging, storage and transportation.

A second stream of thought associated with the emergence of contract farming in Asia is that contract farming can actually lessen public sector expenditure. That is, instead of large resources being spent by governments providing agri-services for a large number of atomistic farmers, the same service can be provided by the private sector through contract farming.

On the income side is the fact that the newly emerging agribusinesses of Asia, such as fast food chains, supermarkets, packaging plants and hotels, collectively provide significant new opportunities for market-oriented production. This is because they have specific requirements in terms of either product or method of production that can be best supplied through an organized system of procurement.

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8 It is noted that that in the ADB's India: Agribusiness Development Support Project it was recommended that the Project take steps to illustrate the benefits of value chains. Specifically, the following crop value chains were suggested:

State	Value Chain
Himachal Pradesh	(i) off-season vegetables, (ii) pome fruits, (iii) stone fruits, (iv) medicinal, aromatic and dye plants, and (v) vegetable seed
Punjab	(i) kinnow / sweet orange, (ii) potato, (iii) onion, (iv) flower seed, and (v) pears
Sikkim	(i) ginger, (ii) cardamom, (iii) floriculture (primarily Cymbidium orchids), (iv) citrus, and (v) passion fruit

9 See Little, P. D., and Watts M.J. 1994. **Living Under Contract**. Eds. Madison: University of Wisconsin Press.

10 It could be argued that the "green revolution" that transformed India in the 1980s from being a net grains importer to being self sufficient in grain production was a form of contract farming. This is because the government offered the growers a minimum price support (MSP) if they the identified crops. If that is the case then the general consensus is that it was a very poor contract because there was open ended tenure and no termination clause. As a result, the MSP "contract farming" has lead to, at least in the Punjab, to mono-culture, over-fertilization, excessive watering resulting in soil degradation, a discouragement to diversify into other non-MSP crops, loss making excessive stocks, a widening gap between the international markets and domestic reality, and in some states some parlous finance.

Contracts are an important mechanism to coordinate production, distribution, and retail arrangements between different actors in the value-chain. In the context of agriculture, Eaton and Shepherd (2001)[11] define contract farming as "an agreement between farmers and processing and/or marketing firms for the production and supply of agricultural products under forward agreements, frequently at predetermined prices."

However, the main idea behind contracts is that they establish the "rules of the game." Specifically, a contract of whatever nature codifies the rules of transactions through the allocation of three key elements: value, risk, and decision rights. A successful contract will thus allocate value, risk, and decisions in a way that is mutually beneficial, ideally sharing risk and improving quality and production.

Contracts will typically specify various details regarding:

- Terms of trade such as prices, quantities, delivery dates, and payment terms
- Input provision
- Production specifications such as specific production practices

At the same time, not all terms will be formally specified; indeed, there are often good reasons to leave certain terms unwritten to prevent future hold-ups in the wake of changes in market conditions. However, it is important that enforcement mechanisms exist, whether formal or informal, that mediate disputes and sustain long-term relationships between parties. Indeed, where risk is a major component of transactions, contract flexibility is common, requiring high levels of social capital to enforce such relationships.

Many different types of contracts can be employed depending on the type of product and partners in the relationship. In the context of agriculture, Eaton and Shepherd (2001) identify five types all having at their core some aspect of how trade, value, and risk are to be shared, either explicitly or implicitly.

Contracts do not work for every product. Where products are relatively undifferentiated, the costs of organizing the value-chain to utilize contracts are high, relative to engaging in market-based transactions. As products become more specialized and issues of quality and process more important, greater coordination is required and contracts are potentially more useful[12].

In the main, contract farming does not tend to work for vegetables destined to the fresh market. An interview was held with an Indian distributor who has abandoned contract farming for a particular form of his business and instead has moved to a more elaborate value chain approach[13]. His core business was the supply of fresh produce, especially vegetables, to retailers and the food service sector. He found that, whilst his contract farmers complied with his requirements to the letter, they could not control the weather. Thus the distributor had flushes and droughts of produce that was in oversupply/undersupply to the retailers and food service sectors for which he had contracts. He was forced to quit the unexpected surplus on the wholesale market at a considerable loss. As a result he will not enter contract farming for vegetables again. However as the list below shows Asia does have a number of successful examples of contract farming for fresh vegetables.

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11 Of all the literature on the subject of contract farming, this study is seen as seminal and the one most frequently cited by other writers.

12 It would be a useful exercise to establish what Goletti (2005) calls the "crossing point" for specific products in terms of the level of quality or product specificity that contracts are a more useful form of value-chain governance than reliance on the market.

13 Pers.com. K Swarmy. Kolkata. June 2005.

Contract farming for processed products is much more successful. The Asian Development Bank has identified a number of successful contract farming enterprises in India in the processed product sector: tomato production in Punjab, medicinal plants in Chhattisgarh, and tea and spices in Kerala. The successes are manifested in terms of higher employment, more stable prices, and higher income. In Vietnam there have been successes with Lam Son Sugar Company LASUCO and An Giang Agricultural Technical Services Company ANTESCO which conducts contract farming on baby corn and green soybean[14].

Other successful examples of contract farming in the Asia-Pacific region are:

- In Indonesia's western Java, a religious school organized around 450 local farmers to supply 20 tonnes of potatoes a year to supermarkets and wholesalers[15].
- Thailand has a number of successful examples of contract farming.
  - In the San Sai district, a farmers' group exports under contract dried longans to China.
  - The country's sugar crop of around four million tonnes, is grown under a contract system that involves 200,000 farmers.
  - The country's snap-frozen vegetable industry for export (mainly soybean, green beans, and baby corn) come from 30,000 farmers.
  - Chrysanthemum and fresh vegetables are grown under contract for wholesalers in the Chiang Mai and Bangkok markets.
- In Bangladesh, BRAC, POSHIKA, and PRAN[16] provides quality input supplies, technical advice, and a guaranteed buy back price at harvest.
- In Sri Lanka around 15,000 rural households produce approximately 12,000 t of gherkins.
- In the Pacific much of Tonga's squash production for export to Japan, and Fiji's ginger and taro exports come from a form of contract growing between the exporter and the producer.

In order to facilitate relationship building, there needs to be balance between actors in the value-chain in terms of:

- Market concentration
- Power
- Organizational capabilities

Illustrating the need for balance in market power, a workshop funded through the Asian Development Bank's "Making Markets Work Better for the Poor"[17] agreed that whilst contract farming is profitable for farmers, collectives and enterprises, resulting in benefits for the whole society, contracts in parts of Vietnam have largely been unsuccessful. For example, for An Giang's rice industry, only 10–15% of signed contracts were performed. This is because market forces are not strong enough to make farmers and enterprises voluntarily coordinate with each other. Supply far exceeds demand and, as such, enterprises don't face any competitive pressures from the agrifood market to sign farming contracts to establish their own input material zone. Thus, only few contracts are signed, with the total volume required far below the farmers' production capacity. Whilst this is in contrast to the success of rice contract farming in India, it is noted that one of the ingredients for successful contract

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14 News Release: Linkages Between Farmers and Enterprises for Contract Farming Must be Improved, Workshop Told. AN GIANG, VIET NAM 12 January 2005. Workshop on contract farming funded by the Asian Development Bank in cooperation with An Giang University under the *"Making Markets Work Better for the Poor"* project. See ADB website.

15 Whilst potatoes are an example of a fresh vegetables, it is noted that potatoes can (a) have their harvest delayed (b) spend an extended period during cured, and (c) with reasonable cool and dry storage conditions have an extended shelf life.

16 The first two organizations are NGOs, albeit BRAC has a highly commercial focus.

17 January, 2005. See Asian Development Bank website.

farming is product differentiation. In the Indian case, the rice under contract is basmati, not ordinary rice.

"Balance" can also come in other forms. Small atomistic farmers are hard-pressed to arrange adequate finance, equipment, seeds, fertilizers, and even machinery. They tend not to have access to the latest in technology and agricultural sciences. As a result, the final produce also lacks quality. At the same time, processors are increasingly required to meet ever-rising standards of quality as defined by regulations as well as by the competition. Moreover some of the sophisticated machinery used in food processing, especially in the fruit and vegetable industries, requires certain minimum standards and volumes of produce to be economic. Thus whilst it may appear that the processor has all the power in a contract farming arrangement, this need not be the case. Another Indian example is illustrative. A pea grower in the Punjab grew a particular pea that was much sought after by the processors. When his processor did not give him a contract that the grower thought adequate he withheld his product for two years. On the third year the pea processor agreed to more balanced contract[18].

Contracts are beset with many problems, particularly in terms of enforcement issues among all parties. A key issue is how the enforcement of contracts can be improved. Contracts require the development of both formal and informal enforcement mechanisms that bind parties to the pre-agreed conditions embodied in a contract.

In some instances, this could simply mean designing better contracts themselves and formalizing different or added conditions to the contract. Good contracts address the long term concern of different parties and balance risk on an equitable basis.

Particularly relevant, however, are the development of credible forms of arbitration that resolve disputes and make contracts enforceable. Such types of enforcement could be either formal or informal, or both. Formal means of enforcement include strengthening legal systems that recognize and respect contract law and resolve disputes in a transparent way. Informal means of enforcement involve relying on and/or creating sufficient social capital among parties or using other third parties that act as a type of mediator when contracting conditions break down.

Trust and linkages are inextricably linked. In the absence of an effective mechanism of enforcement, linkages without trust are invariably weak.

Linkages can be strengthened in a variety of ways, but ultimately it is a matter of confidence building between stakeholders; which implies that the process is a long term process without any short-term fixes. Successful contracts are an example of long term process that aims at reducing risk, ensuring compliance with shared decisions, and increasing value. The experience of contract farming in India has been mixed, with several examples of failure with farmers or enterprises reneging on previous agreements. But as has been noted there are also successes.

Whilst it is recognized that contract farming might lead to improved coordination along the value chain, technological change and innovation, and higher value, there is also a perception that contracts might be disadvantageous to some weaker groups including agricultural workers and women[19]. Contract farming may create employment and contribute to the increased income of marginal workers. At the same time, there is the danger that the families involved in contract farming might be part of a vicious circle of poverty and exploitation. Effective contract farming will involve awareness both for farmers and enterprises of

18 Pers.com. Mr. Avtar Singh Dhinssa, Beauscape Farms, Amargarh at Ludihana, Punjab. April 2005.

19 See also Eaton and Shepherd (2001).

alternative options to establish mutually beneficial long-term relationships. Long-term relationships may provide the basis not only for improved planning and more stable income, but also for the development of skills and the undertaking of innovations in production and processing.

Taking all these factors into account, the prerequisites for successful contract farming include:

- Appropriate government policies in land, price, credit and exports[20]
- An appropriate dispute settlement mechanism
- Production capabilities, such as suitable soil and water resources
- Crop characteristics
- Farmer organization that provides a form of community-based enforcement mechanism
- With a processing plant, the identified locality must have an adequate number of farmers agreeing to operate under contract farming systems, otherwise the private sector may not be interested in investing[21].
- With contracts associated with processing there needs to be good infrastructure, roads, suitable transport, and reliable electricity.
- With contracts associated with the growing of high value crops with international supply chain management, there must be air freight and cargo handling facilities.

Once most of these factors are in place, the advantages for purchasers involved with contract farming are:

- Lower transaction costs
- Lower production costs
- Greater control over quantity, quality, and timing of supplies

The advantages for the growers involved with contract farming are:

- Access to an array of agricultural services that were not previously usually accessible
- Lower market and price risks
- The potential to move towards higher priced non-traditional crops that should result in higher incomes

Some unwritten rules have emerged from the experience of at least that of Pepsi in the Punjab. From the perspective of the processor these include:

- Be prepared to spend at least the first year in a revenue neutral position. Move to a profit center only after a while
- Mechanize where possible, such as with seeders, bed makers, mini sprinklers
- Never offer the grower any commercially untested technology
- Ensure the availability and timeliness of adequate and appropriate inputs
- Timely farmer payments are critical.
- Encourage farmers to think in terms of return per area, not prices as such
- Be prepared to deal with a large number of small landholders
- Seek some form of crop insurance to protect against natural calamities
- Maintain a proper data base of farmers
- Give incentives, rewards and public recognition[22]

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20 For example, many Indian states that have not adopted the Model Rule of the revised Agricultural Produce Marketing Act that specifically provides for the application of contract farming.

21 Ironically, PRAN, which was identified above as an example of successful processor (fruit in this case) associated with contract farming, initially faced serious resistance and hostility from the local farmers.

22 In Fiji, the largest processor of ginger would regularly hold farmer days amongst his contract suppliers where leading farmers were publicly given awards and recognition for their efforts.

- At the same time give adequate publicity to the defaulters in the region where the defaulters live
- Do not sign up a third time with two-time defaulters

MARKET INFORMATION

Growers can improve their returns by making better use of market information. There are two aspects to this:
- Accessing better market information
- Understanding how to better use the information

Market Information

Market information is a total seminar just by itself. In an effort to be extremely brief, the following points are made.

The most important, but by no means the only, form of market data is price. Price is how supply is equated with demand. Whilst fruit and vegetable producers must consider price, they must be aware that price refers to a specific instance in time reflecting a specific supply and demand situation. To assess if prices are likely to increase or decrease in the future then the total supply and demand situation must be understood[23].

Supply of any fruit or vegetable can come from two basic sources: local or non-local, with "non-local" being either from within the country or imported. With imported product there are two types of data: volume and price. Both are usually presented in two suites: annual and monthly. Both suites of data note the country of origin. This is important because it allows for the analysis of what one's competitors are doing in the market place.

Three suites of price data are available.

Import

Import data is expressed in CIF terms. CIF means "Cartage, Insurance, Freight", that is, the price of the product landed in the country of use. CIF prices thus cover the purchase price of the product and logistics' costs of getting the product to the wharf/airport/border of the importing country. Fruit and vegetable exporters should never consider that they will get the CIF price.

Both price and volume parameters must be used to establish the true supply and demand situation. One without the other will only give a partial picture.

Most countries report on the price and quantity of imports of relative importance to them. It is thus possible for the same product to be reported in one country but not in another because in the first country it may be important traded item but not in the second. Two quick examples are given:
- Whilst taro *Colocasia esculenta* is imported into Hong Kong, Japan and Singapore, imports are only reported for Japan.
- Japan and Singapore have separate data for broccoli and cauliflower but in Hong Kong the data combines both cauliflower and broccoli.

Wholesale

Wholesale price data is usually presented in annual and monthly formats. In some countries it is available on a daily, weekly, and monthly basis.

23 In a series of Focus Group Discussions in the Indian apple producing state of Himachal Pradesh, the growers stated their greatest demand for market information was production knowledge of the industry in Jammu and Kashmir rather than market prices in Delhi.

Retail Prices

Retail prices are, as the name states, the prices of the product sold at retail. In the main, retail prices can be based on any number of criteria. Common criteria are philosophy of the store chain[24], store type[25], the store location[26], even daily specials. Wholesale prices are considered to be more transparent when compared with retail prices in their reflecting supply and demand and in the geographic area they cover.

Sources of Hard Data

Thanks to advances in the use of the Internet, a great deal of market data is increasingly becoming available. These are in the form of government publications, trade journals, newsletters, and research reports. There are too many sites to list them all here. A number of caveats must be made in regard to using data from the Internet.

- Be careful to note the ***unit in which the price is expressed***. Some sources give a gross sales figure without referring to any volume. Other sources state the price in terms of the size of the pack by which the product is sold, for example the price 'JPY 4,250' may refer to a 5 kg or 10 kg pack. An extreme example is Chinese cabbage *Brassica pekinensis* in Korea where the unit is expressed in terms of two sizes of trucks that convey the product to the market. The unit cited can vary during the year as the peak season comes and goes.
- ***Aggregation*** is common. An example has already been noted above in terms of cauliflower and broccoli. It would appear that aggregation is more common for tropical products than for temperate ones. Mangoes, a product of importance to a number of countries participating at this seminar, are frequently aggregated with mangosteen and guava.
- ***Time*** Data sources on the Internet are a very fluid item. They are posted and de-listed extremely frequently. Sites are constructed and then removed very frequently. In the main, it is difficult to construct consistent time series data in order to build up meaningful patterns.
- ***Payment*** The inescapable fact is that the less money it costs to obtain data, the poorer the quality is that data. Usually, the best data is that which has to be purchased.

Assessing the Three Hard Data Sources

In obtaining and analyzing hard data, it is useful to keep the following assessment in mind:

Criteria	Hard data type			
	Production	Wholesale	Import	Retail
Extensiveness	Limited	Extremely high	Limited	Extremely high
Frequency of publication	Annual: in Japan different crops may be updated monthly throughout the year.	Can be daily, weekly, monthly, and annual	Can be weekly, monthly, and annual	Informally (e.g., media advertisements) extremely frequent. Formally, not as frequent.
Lag time to publication	Long	Very little	Monthly data usually around two to three months	Formally, moderate
Availability	Usually printed format	Hard copy and web based	Hard copy and web-based	Hard copy and web-based
Transparency	High	High	High	Poor
Overall assessment of importance	1	3	2	1
	(1, very poor; 3, very good)			

In other words, wherever possible the most reliable indicator of price for a fruit and vegetable producer is that of wholesale data.

Individual Country Data

An assessment of the data sources of eight countries relevant to fruit and vegetable producers of the eastern APO countries is provided below.

Country	Production data	Wholesale data	Import data
Australia	1	3 Has the marked advantage of becoming highly specific on a fee-for-service basis	1
Hong Kong	1	1	2
India	1	2–3	1–2
Japan	2–3	3	2–3
Rep. of Korea	1–2	3	2
New Zealand	1	1	1
Singapore	1	1	2
Rep. of China	2–3	3	2

(1, very poor; 3, very good)

Assessment

Experience in most of the APO countries at the Seminar shows that there is a low capacity for understanding how market information can be used. Producers and producer groups tend to show no capacity to use the market data other than to check on daily prices. Poor understanding of how to use market data results in producers being unable to take advantage of more remunerative markets.

Two quick solutions are offered to improve the capacity of fruit and vegetables to make better use of market information.

- Provision of data in trend form
- Extension officers should be re-trained so that their orientation moves from production to marketing.

Market Information: The Other Perspective

To date, emphasis of market information has been from the perspective of the producer receiving information from the market.

It must be stressed that market information is a two-way flow. That is, the producer can just as readily benefit if he or she provides information to the market.

In providing information to the market, the producer must be aware that not all sectors of the market require the same information. The following offers some guidelines as to what types of information are required by the different actors along the marketing chain.

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24 Some stores have a high price approach associated with a high quality image, others have a “stack high and price low approach” seen as “we will not be beaten on price”.

25 In most countries there is a marked difference in the pricing policy of convenience stores, supermarkets and department stores.

26 Stores in wealthy suburbs charge more for the same product compared with stores in middle-class and low income stores.

Marketing chain actor	Information sought
Collector/middleman/ exporter/importer	Very heavily economic-based. Specific issues include: • Crop size and quality • Are the official standards of the exporting country satisfactory to the importing country? Examples include food testing standards, such as HACCP and organic certification, and quarantine standards such as phyto-sanitary documentation and testing for MRLs and Certificate of Origins. • Reliability of transport - shipping, air, rail, and road
Distributor, pre-packer, category managers	Still economically based but moving towards product-based. Information sought includes: • Demonstration of commitment to the business • Willingness to develop product mix • Varieties • Seasonality – the availability of product from specific regions at specific times • Are packing materials satisfactory to sustain the journey from farm to end-presenter. • Are shipping documents fault-free and thus requiring minimum attention. • Has there been adequate and specialist postharvest treatment so that the product is will provide a prescribed shelf life. • Are grading standards/product description reliable.
Food Service Sector: restaurants, hotels, fast food outlets, provedores/chandlers	As this sector has a great dependence on forward quoting, a limited ability to change prices quickly and frequently, and, above all consistency, what they look for are messages that demonstrate the three R's: Regular Reliable Repeatable.
Retailers: convenience stores, supermarkets, department stores, hypermarkets	Retailers are keen to find out about product factors: taste, appearance, freshness, freedom from deleterious influences, and general health benefits. They also want to know about economic issues: • What is the product's shelf life and usual wastage/shrinkage factor. • Will the introduction of this product be at the expense of another product - that is, limit sales rather than build sales. • What margins can be made from the product. • How will the supplier support the product in terms of: - Discounts - In-store promotion - Sampling - Cooperative advertising - Speed at which problems will be addressed. Because of increasing litigation, retailers are keen to know about what is called traceability. Specific issues include: • Testing regimes that can competently identify bacteria, viruses, parasites, fungi, toxins • Environmental issues of heavy metals (lead, mercury) and persistent organic pollutants such as dioxins[27]

SUPPLY ORIENTED OPTIONS

The principle supply oriented option for fruit and vegetable producers to increase their income is through supply chain management.

Supply Chain Management

Supply chain management refers to the process whereby the movement of a product(s) from the initial supplier to the penultimate user[28] occurs with all non-value adding expenses removed. Usually supply chain management is between partners such as a retailer and a preferred supplier, or a restaurateur and a preferred supplier of a particular ingredient.

From a supplier's perspective, supply chain management can mean more than this. It can alter the method of selling from being an FOB supplier to a CIF seller. It can mean that with due care, the seller can sell at a higher price to the penultimate user whilst actually providing the penultimate user with a lower cost.

Successful supply chain management can be summed in the one phrase; detail, detail, detail.

In reality it means studying in detail the entire process from harvest to the penultimate user. In doing so, all steps and costs should be established. After that, it is a matter of establishing what economies can be exercised along the way to the benefit of both parties.

The principles of supply chain management will be illustrated with two examples. They have been deliberately chosen as they are quite extreme situations and thus illustrate well the procedures that are involved.

Export of Taro from Niue to New Zealand

Niue is a tiny island state in the South Pacific. In 2000 a UNDP-FAO project sought to develop exports from the Island. Whilst there is a little trade in vanilla, fish, and handicrafts, exports are dominated by taro (*Colocasia esculenta*) that goes to the one geographic market, Auckland in New Zealand and to one market segment, Niueans in Auckland, by one transportation method, ship that usually arrives once a month.

All exports are shipped. Whilst there are regular shipping services to Niue, the major contrast between the size of the ship and the size of the wharf is a major factor. Cargo has to be loaded onto lighters and transferred from the wharf to the vessel. If there are swells then loading is not possible. There are virtually no postharvest or storage facilities on the island. Taro, which is a largely non-perishable crop, is the ideal product to exported.

A detailed study of the costs involved in the shipment of taro was made. Given the sensitivity of New Zealand to quarantine issues and the impact of quarantine on Niuean exports, the study initially concentrated on the costs of quarantine. It soon, however, became obvious that these costs were either a YES or NO issue rather than one of establishing what could be avoided. Thus efforts were focused on avoidable costs associated with the supply chain. The detailed study is summarized below.

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27 A useful overall source document is *Food safety and Agricultural Health Standards: challenges and opportunities for developing countries***.** Poverty Reduction and Economic Management Trade Unit and the Agriculture and Rural Development Department, World Bank. January 2005. Also Jaffee S and Henson S. Standards and agro food exports from developing countries: redressing the balance.

28 By using the term *penultimate user* it is recognized that this is the last step in the chain before the food product is actually consumed. The end consumer is the person(s) in the home or the restaurant or catering function. Our interest is in the step before that, that is the retailer, or the food service sector.

NIUE: Supply chain costs

(* All costs in NZD)

Niue Costs*		
Sacks	2.00	/sack
Labor – packing and loading into containers	2.10	/sack
Sack sewing	0.20	/sack
Port and services charges	155.00	/container
Bill of Lading, documentation, Niue Quarantine, packing	3.50	/sack
MAF - Quarantine - fixed costs		
Inspection fee – 7.40/hour, usually 1.5 hrs	86.10	
Labor to unstack	50.00	
Inspection in approved facility @ 2.25/bag (based on 5000 items in shipment and sample being thus 600 which on 50 taro/bag is 12 bags)	27.00	
MAF - Quarantine - variable costs		
All of above costs plus		
Zone fee if not use MAF but importer's own facility	78.75	
If insect, then for each type of insect I.D.	78.75	
Courier to MAF I.D. site	28.50	
Fork lift to move container, based on full container load	45.00	
Treatment (per container)	140.00	
New Zealand charges		
Port charges/20'	203	
Cartage for 20'	2400	
Add 17.5% for currency and bunkering	420	
Cartage from wharf	140.00	/20
Hire of crane at wharf and at importer's yard to left and drop container		
Devanning	0.26	/package
Storage	0.10	/package
Custom clearance	100	/Bill of Lading

The study showed that economies could be achieved partly on the Niuean end but largely on the New Zealand side. For example, economies could be achieved on all but the bunkering charges. Previously, Niue had used a series of different operators to carry out the services of shipping, documentation, and land transportation. The cost of each of these individual activities accumulated to a large total. There was, for example, the need to hire a mobile crane to lift containers off the truck onto the ground at the importer's yard. It however became possible to establish one company that could undertake all of these activities. Although port charges were higher, the company was able to reduce seven of the charges quite considerably. The company was, for example, able to use trucks equipped with cranes for loading and unloading. Because the company had considerable shipping interests it was able to lodge custom clearance documentation electronically. Most importantly, because of the involvement of a single company, there was only one VAT bill[29]. Niue was eligible for a

29 Value Added Tax. Also called Goods and Services Tax. A non-avoidable New Zealand government charge.

100% rebate on the VAT, owing to the fact that it was not a New Zealand based exporter. Systems in New Zealand allow for payment of the rebate to coincide with timing of the payment. Thus, one can pay the VAT and immediately receive the rebate. By dealing with the one agency, and after a one-off payment, Niue was able to enjoy off-setting VAT payments with VAT refunds.

The total savings amounted to around NZD2,000 per container.

Niue chose to pass these savings onto its New Zealand importer. In other words it maintained its FOB selling price but reduced the importer's Delivered-Into-Store price. Armed with a significant savings, the importer could then reduce the price he charged for Niuean taro to now equal that of the major competition from Fiji that enjoyed massive economies of scale in their shipments to New Zealand.

Export of Summer Vegetables from Bhutan to Bangladesh

In July 2004, Bhutan commenced exporting summer vegetables to Dhaka in Bangladesh.

Because of its altitude Bhutan is able to grow a number of summer vegetables and fruit when production is extremely difficult in the hot summer and monsoonal months in Bangladesh. Bhutan is landlocked. Trucking is the major trade transportation mode and whilst the country has three major exit points, most trade occurs through a single point.

A total of 17 fruits and vegetables were taken to Dhaka. From initial harvest to the end of three days at the retail level in Dhaka took eight days. The route exited Bhutan at Phuentsholing, through West Bengal to Burimari on the India-Bangladesh border, then essentially paralleling the Tista and Jamuna Rivers to Dhaka. The journey took around 30 hours.

In attempting to refine the supply chain, two sets of cost criteria were used:

- Financial costs where there was a direct payment made
- Product costs where for one reason or another the product was subjected to activities that resulted in a loss of product

A total of 18 steps were involved that resulted in computing some form of a cost. From a detail study of these costs, Bhutan was able to identify refinements to the supply chain that allowed it initial savings. The steps are detailed below.

Step #1: *Grower harvests*

Costs at this stage: Farmer production costs, harvesting costs

Weight at this stage: 100 kg

Step #2: *Grower packs*

Costs at this stage: Purchase of tokris or cane baskets, disposal of low quality product

Weight at this stage: 100 kg

Step #3: *Grower delivers to centralized collection center*

Costs at this stage: Transporting to central collection facility

Weight at this stage: 90 kg

Step #4: *Collection*

Product was assembled from the valleys parallel to Thimphu. Some products arrived several days before others.

Costs at this stage: Storage costs. As these were in open buildings at the Ministry, costs were zero.

Weight at this stage: 85 kg

Step #5: *Pack for transport*

A typical seven tonne truck was used to transport the produce from Thimphu to Phuentsholing. The truck was rigged to provide shelter.

Costs at this stage: Labor to load truck. Purchase of rice straw for insulation. Purchase of Hessian to cover the tokris

Weight at this stage: 85 kg

Step #6: *Transport to Phuentsholing*

Ideally the transporting of the produce should be at night in July in order to make use of the lower temperatures.

Costs at this stage: Hire of truck

Weight at this stage: 85 kg

Step #7: *Transfer to Indian vehicle, Phuentsholing*

Despite the legal situation that Bhutanese vehicles can freely travel through West Bengal, it is dangerous for Bhutanese registered vehicles to do so. This is because Assam separatists are likely to shoot at/kidnap Bhutanese vehicles.

There are two options: 1) to wait in a convoy with an armed escort provided by the Indian Government; 2) to transfer the produce to an Indian registered vehicle. It was decided to take the second option to save waiting for the convoy to assemble. This can take an indeterminate amount of time during which the produce would further deteriorate in the summer sun.

In taking the second option, the transfer had to occur before 21:00 hours in order that the Indian laborers where able to return to India before the border gates were closed. This affected the timing by which the truck from Thimphu had to arrive.

Costs at this stage: Hire of labor

Weight at this stage: 80 kg

Step #8: *Documentation*

Nine sets of documents of six pages each were required in order to move from Bhutan to Bangladesh through India. One person spent a whole day in assembling the documentation.

Costs at this stage: Imputed costs of manpower required to complete the documentation. Actual costs associated with various stamps

Weight at this stage: 80 kg

Step #9: *Transport to Burimari*

Burimari is the transport border crossing from India to Bangladesh.

Costs at this stage: Hire of truck

Weight at this stage: 80 kg

Step #10: *Border documentation – India*

Papers must be completed in order for the produce to exit India. Personnel must have their passport requirements completed. There were 96 trucks in the queue waiting to get their documents processed. Because of the perishable nature of the load, the Bhutanese truck went to the head of the queue. For at least one hour there was no movement by any official to undertake any effort to process the documents.

Costs at this stage: Deterioration in produce quality

Weight at this stage: 80 kg

Step #11: *Border documentation – Bangladesh*

Personnel accompanying the load have to fulfil the passport requirements. Immediately inside the border, papers have to be inspected by the Border Security Force (BSF). The BSF are empowered to require that partial or full unloading can occur but not in this case.

Costs at this stage: Deterioration in produce quality

Weight at this stage: 75 kg

Step #12: *Duty to enter Bangladesh*

Despite Bangladesh and Bhutan having a duty free status, the local Customs officer was not aware of the arrangements. Further, documentation was provided by the Royal Bhutanese Embassy in Dhaka from the Bangladeshi Ministry of Foreign Affairs as to the status of the Agreement. The local Customs official considered that he was not bound by the ruling of another Ministry. Five hours were spent in solving this issue. This included the Bhutanese requiring going to the nearest bank some 20 km away to affect the duty transfer.

Costs at this stage: Deterioration in produce's quality. Duty costs

Weight at this stage: 75 kg

Step #13: *Transfer to Bangladeshi vehicle*

A refrigerated vehicle had been arranged to transfer the produce from Burimari to Dhaka. The produce had to be transferred from the Indian vehicle. The Indian truck was not permitted to return empty to India until the documentation had been completed. This added to the time that the truck was idle, a delay that is factored into the costs of hiring the truck.

Costs at this stage: Labor to transfer the produce

Weight at this stage: 75 kg

Step #14: *Move to Dhaka*

The journey to Dhaka took over ten hours. Without a refrigerated vehicle, this journey should be done at night.

Costs at this stage: Hire of refrigerated vehicle

Weight at this stage: 75 kg

Step #15: *Regrading at Dhaka*

Once the produce was delivered to the cool store in Dhaka it had to be unloaded and then inspected. After grading to remove produce that had deteriorated, the produce was further graded in terms of expected shelf life (one, two and three days). The produce was then repacked into cartons.

Costs at this stage: Hire of cool stores (labor to unload the vehicle is included in cold store charges). Hire of labor to regrade produce. Purchase of cartons

Weight at this stage: 65 kg

Step #16: *Delivery into store*

Produce was transported to the store.

Costs at this stage: Hire of vehicle to transport to store

Weight at this stage: 65 kg

Step #17: *Receipt into store*

Produce when delivered to the store was weighed by store officials for payment purposes. All weights were then discounted by between 10–20% from the sale weight. This was the store's method of accommodating shrinkage.

Costs at this stage: Loss associated with store policy of accommodating shrinkage

Weight at this stage: 60 kg

Step #18: *Returns*

All produce considered unsalable by the store was returned without any credit from the initial estimated shrinkage factor.

Costs at this stage: Returns of approximately 10%

Weight at this stage: 55 kg

Lessons

The above examination revealed a number of avoidable steps. These relate to:

- Product loss associated with waiting for centralized collection
- Product and financial costs associated with moving product from a Bhutanese vehicle to an Indian vehicle at the Bhutanese-Indian and the Indian-Bangladeshi borders
- Product and financial costs associated with multiple handling in Dhaka
- Financial loss associated with the store returns policy in Dhaka

It was estimated that the purchase of a cold storage vehicle in Bhutan would have increased handling charges but reduced product loss. On balance, the expenditure on a cold storage vehicle would be a net gain for Bhutan[30].

Whilst economies of scale would operate on the size of the vehicle used, Bhutan was aware that it must resist the temptation to maximize the load within the vehicle in order to reduce per unit transport costs. This is because vital space is needed to ensure optimum airflow and thus optimum use of the refrigeration facility. It must also accept cognisance must be made of the postharvest physiology of co-loading products with different temperature requirements and possible conflicting ethylene properties.

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6. NEW ROLES OF GOVERNMENT IN IMPROVING FRUIT AND VEGETABLE MARKETING AT NATIONAL AND LOCAL LEVELS

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INTRODUCTION

The fruit and vegetable industry integrates a wide range of crops and products, each with different supply conditions, marketing needs, and demand trends. While these products have common marketing channels and somewhat similar problems, the uniqueness of individual fruits, nuts, and vegetables should be kept in mind. Marketing requirements for fresh fruits and vegetables differ greatly from those for processed products. Marketing systems in developed and to a lesser extent in developing countries have undergone major changes in recent years. Major trends include decentralization and direct marketing, geographic concentration and specialization of production, market development, inter-regional competition, industry consolidation, increased imports and exports, and vertical integration of production and marketing systems. New fruit and vegetable technologies greatly influence the marketing of these crops. Mechanical harvesting has altered the location of fruit and vegetable production and in some cases the quality of these fresh produce items. Vegetables can be produced in green houses. Plant growth stimulants and retardants can be used to influence yields and the timing of crop production and controlled atmosphere storage has extended the availability and keeping quality of produce.

Fruit and vegetable marketing systems are influenced by production factors such as seasonality and geographic specialization of production; characteristics of the fruit or vegetable such as perishability and bulkiness as well as market characteristics, such as variations in price and quantity and alternative product forms. Food marketing systems therefore evolve in response to unique product and industry characteristics.

Notable among these characteristics and related to perishability and the biological nature of production is the difficulty of scheduling the supply of fruits and vegetables to meet market demand. Fruits and vegetables are subject to high price and quantity risks with changing consumer demand and production conditions. Unusual production and/or harvesting, weather conditions or major crop diseases can disrupt fruit and vegetable marketing patterns. Extended production periods and high fixed costs of orchard crops also result in price and marketing problems. Producers are consequently not very sensitive to short-run price changes and may produce at prices below total costs for extended time periods.

The modern food marketing system requires price and supply stability for market planning and merchandising programs. A number of marketing arrangements have evolved to provide stability in the fruit and vegetable industry. Processors use grower supply and price contracts to ensure capacity utilization of their plants and to assist in sales programs. Many large wholesalers have representatives in major producing areas to ensure steady supplies for their merchandising programs. Producer cooperatives assist in orderly marketing of biologically sensitive, perishable produce.

The biology and perishability of fruits and vegetables also adversely impacts upon effective supply control in this industry. Large numbers of unorganized producers of fruits and vegetables throughout the country and the lack of government programs, which limit the acreages of production of these crops, results in the producer being a price taker.

TRADITIONAL ROLES OF THE STATE IN AGRICULTURAL MARKETING

Farm policies are attempts to achieve social goals through the instruments and powers of government. Given the critical importance of rural and food economics, some form of government involvement exists in farm and food markets in most societies. In developed countries, government farm policies aim to solve "farm problems" – which often include factors such as unstable farm prices and incomes, periodically declining farm prices, and low farm income relative to non-farm incomes. In developing countries, improving marketing of fruits and vegetables is important because of:

- rapid increases in demand for these produce items by growing domestic urban populations;
- opportunities to earn foreign exchange through the export of high-value, out-of-season produce;
- the perishability of these fresh produce items;
- the income-raising opportunities offered to small farmers by these fresh produce items;
- the contribution of these fresh produce items to employment owing to their labor-intensive production, handling and sales requirements.

The need for improvement in specific practices or in the whole structure of marketing is, however, evident. The introduction of new procedures, construction of new facilities, organization of new enterprises, implementation of collaborative activities, and the suppression of undesirable practices necessitates the development of new initiatives for restructuring of marketing systems. Such initiatives may be spearheaded through any of the following mechanisms:

Private Enterprise

Improvements in marketing systems in many countries are initiated through private traders and corporate firms who seek profit earnings, by offering to the community, services for which it will pay an attractive price. Prominent among such services are those required to bring agricultural products from farm to consumer. Thus a large number of individuals seek to engage in marketing, to assemble the output of small farms, to carry produce to consumer markets and to break large consignments into convenient lots. This is particularly evident in countries where opportunities to cultivate land or work in industry are relatively limited. Competition among marketing enterprises motivates them to seek less costly and more effective handling methods and to improve the economic operation of plants. In situations where this competition is intense, it ensures that producers and consumers benefit through the competitive cutting of prices.

Group Action

Marketing improvements also stem from the collaborative action of individuals or firms involved in the marketing of a particular product or combination of products. This type of collaborative action may be voluntary, as occurs in situations in which farmers or consumers collaborate by joining a co-operative, in order to provide marketing facilities or to follow certain sale producers for their mutual benefit. Collaborative activities may also be compulsory, as in the case of commodity marketing boards, set up with statutory powers. Such boards prescribe rules and procedures which are authorized by the Government, for the production and handling of commodities.

Government

The need for the assistance of governments in initiating and facilitating the organization of marketing activities is now recognized in many countries. This has resulted in regulatory measures and in the allocation of technical and financial resources to improve marketing efficiency. Major measures by which improvements could be effected include the following:

a. *Regulatory*: Specification of the rules by which market enterprises must abide in the mutual interest of producers, traders and consumers.
b. *Facilitating*: Development and implementation of programs designed to assist marketing systems in providing improved service to users. Such programs may include both regulatory and facilitating elements. A particularly good example of this is the regulatory nature of quality grading requirements and compulsory standardization of packages on certain commodity markets which facilitate trading through description and market news.
c. *Interventionist*: Government entry into the purchase, sale, storage and movement of traded commodities, either to influence their pricing and movement or to supplement existing market channels and increase competition.

CHANGES IN THE ROLE OF THE STATE IN AGRICULTURAL MARKETING

The 1960s witnessed significant public sector involvement in the agricultural markets of a majority of developing countries. This typically took the form of a marketing board that had a legal monopoly, or a stabilization fund which purchased crops through a system of licensed agents. The effectiveness of this public sector intervention was varied. In the 1980s, the World Bank introduced a policy-based lending system, described as "structural adjustment" programs. These long-term, growth oriented, "supply side" policies, were designed to facilitate commercial activity and increase production in order to sustain, and eventually raise, living standards.

Market liberalization which is the central structural adjustment strategy that has been adopted is based on a perception that government interventions in the market introduce distortions and inhibit the development of a healthy private sector, and should thus be removed.

Liberalization of agricultural markets usually involves:

- Liberalizing prices (e.g., removing controls on producer and consumer prices, allowing interest rates to rise to market determined levels, adjusting exchange rates and abolishing subsidies);
- Promoting private sector (for example, improving access to finance for commodity traders and marketers, and improving market information, transport and storage);
- Minimizing the role of government (for example, by privatizing or contracting out key functions, closing public enterprises and limiting the mandate of parastatals);
- Introducing measures to increase the efficiency of the remaining state-owned enterprises; and
- Removing quantitative and administrative controls on trade (e.g., removing quotas on crop purchases and movement, abolishing licensing arrangements, and removing restrictions on the internal and international movement of produce (Kydd and Spooner, 1990).

Structural adjustment policies have been criticized for being based on abstract, theoretical models of the "market" which are far from reality. In any event, since states have always been involved in setting the basic rules under which markets operate, it is an oversimplification to understand market liberalization as a means of "getting the government out of the market." It involves a process of redefining property rights, including the relative role of private and public sector and is therefore a broader concept than privatization.

New Roles of Government

As was pointed out earlier, the role of government in agricultural marketing has changed during last two decades from interventionist to regulatory and facilitating. In this process, the first priority for improving marketing is to expand awareness in influential circles of what marketing means, who is involved in marketing and how markets operate. The failure of many agricultural development programs to attain their goals, has been due to poor understanding of the marketing link, by officials at the policy making level. Their concept of marketing tends to be restricted to the assembly of produce in rural and in export markets. Their knowledge base on the strategic area of wholesaling is quite limited. The role of marketing in providing an incentive for production is not appreciated, and marketing as a multiplier of development is seldom considered.

Notions of agricultural marketing held by national policy makers are often based upon inaccurate information and half-truths handed down over the years which are accepted without question.

Yet another problem is the lack of coordination of responsibilities for agricultural marketing and the dispersal of these responsibilities among various ministries which results in the duplication of effort.

Need for Effective Government Marketing Services

The tenacity of these erroneous notions of agricultural marketing in government is a measure of need for better marketing policy units. The government structure must therefore include a unit with trained staff in marketing, equipped with the capacity to systematically collect and analyze information, and formulate recommendations for consideration by the responsible governing body.

A marketing development unit is also required to undertake the planning of facilities and services in order to cater for the expansion of farm production in line with population growth. Improved transportation services, storage, drying and processing facilities, additional finance for marketing, consumer surveys, new marketing institutions and adaptation to changing patterns in world and domestic agricultural structures will be required. Field studies based on direct contact with production and marketing enterprises and with people will be essential. Governments must facilitate the efficient operation of marketing systems through the provision of the following services:

- *research*, initially to advise the government and subsequently to assist enterprises engaged in marketing;
- *advice*, primarily for the government, then through extension and similar services for enterprises engaged in marketing and people who depend on it (specially, producers and consumers);
- *information*, pertinent to dissemination of supply, price outlook and technical information, first to government planners and policy makers, then to marketing operators and those served by them, including producers and consumers.

The controls on marketing maintained by governments are initially designed to provide a legal framework for the conduct of purchases and sales. This may then extend to protect producers and consumers against fraud and harmful practices, and to maintain the reputation of produce in particular markets. The establishment of uniform weights and measures, product quality standards and grades, and standard packaging, containers and labeling follow. For many products and market areas, such specifications may be promulgated as a guide for voluntary adoption. Legislation to enforce them is recommended when the advantages are quite clear, the means of enforcement are available, and the cost to those affected, as well as to the government is acceptable (Abbott, 1986).

Government Regulatory Programs

Regulatory programs instituted by Governments involve exercising police authority to safeguard the welfare of those industries with which the regulations are concerned, and to protect the health and the interests of those who consume the products of the industries.

Regulations emphasized in recent years include the following:

1. Regulations to protect and promote consumer health and safety
2. Regulation of marketing facilities

There is recognition today that in a modern, complex society the consumer cannot possibly be expected to have complete knowledge about all choices and purchases. Regulations to protect and promote consumer health and safety generally strive to assure adequate and accurate information so that consumers can make informed decisions and protect themselves from products and practices that might be harmful. Generally, the purpose of these laws is to prevent the shipment of adulterated or misbranded foods. The administrator of such regulations also has the power to establish minimum quality requirements and filling of containers for most packaged goods. The law also provides for labeling of contents.

The increased use of chemicals in food production and processing has led to new regulations, which set tolerance levels for pesticide residues on food after harvest. In addition, such regulations prohibit adding to food any substance that may cause cancer in man or animal and provides for testing of farm chemicals and control of coloring agents used in food processing. Such regulations set up codes of ethics for advertising, which make false and deceptive advertising an unfair method of competition and thus illegal.

Nutritional lobbying provides consumers with information on the nutritional levels and cost of alternative foods. In most developed countries, it is mandatory that food processors declare the caloric, protein, carbohydrate, and fat content of their products, along with the percentage of the recommended daily allowance of seven vitamins and minerals that the product provides.

Regulation of Public Marketing Facilities

Governments may also regulate the operation of transport and markets in order to protect trade between separated buyers and sellers. Fruit and vegetable markets, commodity exchanges and other large markets are often closely regulated in order to assure proper registration, inspection, reporting of movement and compliance with specific trading rules. Governments may also specify rules for warehousing. Regulations designed to maintain high standards of efficiency in the operation of public storage can greatly assist in reducing the risk factor associated with storage costs. Codes of storage practices cover standard structural types and measures to reduce or eliminate loss and waste. Appropriate insurance coverage and other steps to safeguard against loss by fire and theft would also be required by such laws.

Government Facilitating Programs

Governments can foster marketing improvements by making available various resources and services available to the marketing system and its users. Notable among these are the following:

a. Investment and credit
b. Bonded warehousing
c. Standard contracts
d. Market information
e. Research
f. Marketing education and extension programs

Although all of these resources and services offer potential for increasing the efficiency of the agricultural marketing system, two facilitating programs, namely, credit and market information which have been mostly emphasized in the process of market liberalization will be discussed in more detail here.

Investment and Credit

The construction of needed transport facilities such as railways, roads, harbors and permanent port equipment is appropriate for the allocation of long-term investment capital. In such programs, investment in roads and bridges designed to permit all-weather movement of agricultural products warrants a prominent place. Additional services are, however, needed to meet the seasonal requirements for perishable foods. In cases where potential savings on weight and quality losses and extensions of economic production are justified, governments may undertake construction and subsidize the operation of transport facilities that would not otherwise be feasible.

Government programs for the construction of suitable storage and handling facilities for agricultural products at local assembly and disposal points are underway in many countries. Such programs can either be financed directly, or through the provision of credit to private or co-operative enterprises undertaking approved construction programs.

Government can facilitate the introduction of improved methods of handling, processing and distribution of farm and food products. Investment in new equipment may be encouraged by credit and relief from import restrictions or tax burdens.

Where the development of export markets is vitally important, governments have sometimes set up special export credit systems to relieve merchants of some of their risk and credit burdens. Otherwise the long waiting period for payment, uncertainty concerning the credit-worthiness of buyers, and heavy initial transport costs involved in exports to distant markets, tend to deter many potential shippers.

Where co-operative organizations of producers or consumers offer solid prospects of raising the level of competition in bargaining, financing, transport, storing and processing, governments generally assist their establishment. Such aid may take the form of technical advice, tax exemption privileges, and loans at low rates of interest safeguarded by central supervision of their policies and procedures.

In view of the supply cost, risk and organizational factors which make the provision of short-term credit on agricultural produce an unattractive proposition in the less commercial economics, alleviation of the credit scarcity at the farm and country buyer level seems likely to depend on substantial assistance from governments. In many countries governments are now making credit available on especially favorable terms. They are also subsidizing the cost of administration, both by maintaining government credit organizations and by assisting the establishment of co-operatives to manage the distribution of credit at the village level.

Market Information Service

Another area in which governments can facilitate market operations and improve efficiency is in the provision of information on stocks, impending supplies, movements, consumption and prices. Provision of such information enhances its accessibility to farmers, traders and consumers. Market information pertinent to government sales and price stabilization operations must, however, be accurate. The following steps are critical for the practical establishment of such an information program:

(i) Investigate the need for information additional to that already available and determine what data would be useful, to whom, at what time and in what location;

(ii) Ascertain the sources from which such information could be obtained, the means by which it can be obtained and at what cost;

(iii) Organize an appropriate system of assembly and dissemination.

Two main subjects which must be ascertained are the characteristics of the main products marketed and the organization of the marketing channels which handle them. Both factors together determine the type of market information required and how such information can be used in a particular commodity line. Farmers generally require information on prices obtainable through the various outlets to which he they can sell, and for guidance in formulating production plans for the future.

Market information is, in most cases, useful only to commercial farmers. In situations where there are few or no commercial operations the value of an elaborate market information service may, therefore be questioned. Farmers may need information on prices, production and trade only in their local areas, rather than nationally, if trade movement between regions is restricted. The same is true for the retail trader if he can only obtain supplies from local sources.

It is clear that developing an efficient, relevant and sustainable market information service is far from easy. While the benefits of such services appear unarguable, the failure of many countries to operate reliable, accurate and lasting services does question the wisdom of FAO and other agencies in promoting market information service for all situations. Attention must be paid to the capacity of the country and the counterpart organization to operate a service, both in terms of technical capacity and in terms of ability to meet recurrent costs. Institutional arrangements need to be closely examined and the potential for private-sector involvement should be investigated. Basic steps can be taken to avoid some of the obvious problems. The greater the level of research at the beginning, the more likely is the market information service valuable to its target users. Tailoring the size and scope of the service to available budgetary resources is likely to result in greater sustainability. Ensuring that all operatives are fully trained should result in a more accurate market information service.

Two major issues which need to be addressed at the outset if an efficient and sustainable market information service is to function are institutional structure and sustainability.

The Institutional Structure

The most sensible institutional setting for a market information service will vary from country to country. In some countries, it may be preferable to utilize the Statistics Services since such services tend to have in place a network of trained data collectors. It must, however, be acknowledged that government statistical agencies are not generally known for the speed with which they publish their data and may not, therefore, be too efficient at daily price dissemination. While agricultural ministries generally have extensive field networks, staff of these ministries may neither be adequately qualified to neither undertake work on price collection nor be particularly motivated to do this type of work. In situations where market information services are operated by ministries of agriculture, statistics organizations, continue to collect market price information for their own purposes, thus resulting in duplication and wasteful use of scarce resources. Such a situation clearly needs to be avoided, and requires a willingness to collaborate on the part of the respective ministries or organizations.

An economic solution to the problems of sustainability faced by many market information services would be to oblige users to bear the costs by charging for the information. However, particularly in most developing countries, produce is mainly offered by farmers in small quantities. Such farmers lack information and are in a relatively weak bargaining position. It is neither feasible nor necessarily desirable to charge them for information. Thus, the vast majority of market information services world-wide are run as free public services. Market information is seen as a public good, i.e., something like roads or clean water, which should be made available to all, not just those willing and able to pay.

While public services can, to a certain extent, go commercial by attracting advertisements and sponsorship, it is unlikely that many will be able to fully cover their costs, let alone make a profit. Thus opportunities for private provision of market information are probably few. Private market information services appear to work best when they are able to use already available information; dissemination costs being usually a good deal lower than collection costs. Thus private services in South Africa can access the databases of the wholesale markets. A similar operation is carried out in Beijing, with private distribution of information gathered from public wholesale markets.

It may be preferable for governments to aim to steer a path between a market information service, fully operated by the state sector and one left to the private sector, which provides information only to those who can afford it. An autonomous, semi-government department often has to be paid by the Treasury or Ministry of Finance whereas autonomous bodies can generate and retain revenue. This gives such bodies the incentive to seek commercial support for a market information service, which would be lacking in a Ministry. Such organizations can also often be free of restrictive public-service employment regulators, which gives them management flexibility and the opportunity to be more cost effective. An alternative approach may be for a government to finance the service, but for data collection and dissemination to be undertaken by the private sector.

Ensuring Sustainability

A 1999 FAO survey reported that numerous market information services had been established by donors, but had subsequently run into problems once the donors had left. Several existing services presently operated with donor support would appear likely to follow the same route. Free computers, fax machines, cars and motorbikes can be very attractive, until they have to be replaced. Recognizing the very real problem of low government salaries in many countries, donors have also often paid salary supplements to staff employed in market information services. Unfortunately, when the donors leave so do the staff, who are generally unwilling to return to lower government salaries. Thus an efficient, donor-supported market information service can often be illusive, as salary supplements and other benefits are often the main reason for maintaining staff morale. Housing a market information service in an autonomous body not subject to government salary controls may avoid this, although the problem of mechanisms for generating sufficient funds to pay for its operation would still remain.

Despite the difficulties associated with sustainability after donor assistance has ended, there appears to be a strong need for technical, and some financial, assistance to most countries seeking to initiate the development of market information services. There is, however, a general trend world-wide towards reduced technical assistance and projects are tending to have a shorter time frame. FAO's experience bears out the view that few countries can be assisted to establish a market information service on the basis of short-term consultancy input. For most countries a one-year project with full-time technical assistance input is the minimum required.

Funding of information dissemination is in future likely to be one of the main areas which threatens the sustainability of market information services. Services can no longer take for granted free access to government-owned radio stations and will increasingly have to explore ways of obtaining funding for broadcasts. Many countries have already run into problems because they could not, in the long run, afford to finance dissemination. Thus at the design stage of an market information service, an early port of call should be to the media to ascertain their charges, and these charges should be budgeted. At the same time, possible sponsors should be identified. There would appear to be no reason why sponsors could not be found for market information broadcasts. Indeed, in Sri Lanka, vegetable wholesale prices are broadcast on a commercial radio station and this program is sponsored by a private fertilizer company. The possibility that more detailed information than that broadcast on the radio could be sold should also be explored.

CONCLUSIONS AND POLICY IMPLICATIONS

Throughout history and in most societies, governments have intervened in farm production, prices, and income. But fruits and vegetables which are not considered staple foods have not received deserved attention by governments. This is against the fact that fruit and vegetable marketing systems have been influenced by production, characteristics of the produce, and market characteristics such as perishability, large price and quantity variations, seasonality and geographic specialization of production. For most fruits and vegetables there are alternative markets. These alternatives provide opportunities for market development in the fruit and vegetable industry. Producer organizations, private firms, and cooperatives have invested in new product development and promotional programs to expand sales and improve prices. These processing markets have greatly expanded the potentials for differentiating fruit and vegetable products through branding, packaging and other means. There are attempts to develop consumer brand loyalty for fresh fruit and vegetables which were originally considered nonbrandable products. Such market development programs have altered traditional marketing and competitive patterns. Multiple product forms and extensive branding, and advertising have changed the competitive environment of this industry.

Against this background, the role of government in fruit and vegetable marketing has gone under major changes. Pursuit of "structural adjustment" policies and market liberalization has changed the role of government from interventionist to regulator and facilitating agent. The first recommended rule for the government is not to intervene in the functions that could be done by private firms and cooperatives. Second rule is that if private firms and cooperatives cannot get involved in some marketing functions due to unavailability of resources and services, the government should provide such resources through investment in infrastructure such as roads, transport and communications and extend credit to private firms and cooperatives.

Thirdly, there is an increasing need for government control on marketing to provide legal frameworks for the conduct of purchases and sales, to protect producers and consumers against fraud and harmful practices. Legislation to enforce these frameworks is recommended when the advantages are clear, the means of enforcement are available, and the cost to those affected, as well as to government in acceptable.

Fourthly, the provision of market information services in an important field that governments might exploit in order to facilitate market operation and efficiency. In this respect, two major issues which need to be considered are institutional structure and sustainability. Finally, there is a need for governments to invest in marketing research and extension programs which are considered the most neglected areas in majority of developing countries.

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7. MEASURES TO ASSURE BETTER FOOD SAFETY, MARKETING, AND CONSUMER SATISFACTION IN FRUITS AND VEGETABLES

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INTRODUCTION

Fresh fruits and vegetables are traded worldwide. Twenty to thirty years ago, tropical fruits and vegetables were hardly known in Europe and North America. Today, as a result of globalization, a diversity of exotic fruits and vegetables are available in supermarkets all over the world.

Consumers are, however, very concerned about food safety issues, given the incidence of food borne diseases in fruits and vegetables. Data on the incidence of food-borne diseases associated with fruit and vegetable consumption is, nevertheless, only available in Western countries.

Traders, retailers, consumers and consumer associations increasingly demand quality and safety of the fruits and vegetables that they purchase and consume. Furthermore, wholesalers, retailers and consumers are concerned about the location in which fruits are grown, the working conditions of staff engaged in fruit and vegetable production, whether or not fair trade is applied, as well as the impact of the environment on fruit and vegetable production.

Various quality and safety systems comply with, and respond to questions pertinent to trade and consumers. These systems are subject to certification.

This document discusses some of the food safety and quality systems for the primary sector, as well as recent developments to assure improvements in food safety, marketing, and consumer satisfaction of fruit and vegetables. It will provide a detailed review of certification systems, labeling, the application of management tools for quality improvement and capacity building for better management.

CERTIFICATION SYSTEMS

Some Definitions of Certification

1) "With certification a company gives notice, with justified confidence, by means of a formal statement that a system or a product is in conformance with, respectively, a predefined standard or specification"
2) "A procedure by which accredited certification bodies, based on an audit provide written or equivalent assurance that food control systems conform to requirements"
3) "Certification is a process by which a third (independent) party gives written assurance that a product, process or service conforms to specified requirements" [ISO definition of certification (ISO/IEC Guide 2:1991)].

Why certification?

Certification provides a bridge of confidence between consumers and producers, demonstrates commitment to quality, enhances credibility and adds value to the product.

SQF 1000 Code and EurepGAP are examples of internationally recognized benchmarked certification systems, which combine safety and quality, specifically for the primary sector.

SAFE QUALITY FOOD

The Safe Quality Food (SQF), program is a fully integrated food safety and quality management protocol designed specifically for the food sector. SQF certification provides independent and external validation that a product, process or service is compliant with international, regulatory and other specified standard(s) and enables a food supplier to give assurances that food has been produced, prepared and handled according to the highest possible standards. Based on universally accepted CODEX Alimentarius HACCP Guidelines, the SQF code offers the food sector a mechanism for simultaneously managing food safety and quality. There are two SQF Codes: the SQF 1000 and SQF 2000.

The SQF 1000 Code is designed specifically for primary producers. In addition to Good Agricultural Practices (GAPS), a producer develops and maintains food safety and quality plans to control those aspects of their operations that are critical to maintaining food safety and quality.

The SQF 2000 Code has wide appeal across the food manufacturing and distribution sectors. In addition to Good Manufacturing Practices (GMP's) a supplier develops and maintains food safety and food quality Plans to control those aspects of their operations that are critical to maintaining food safety and quality.

SQF systems find their origin in Western Australia. Western Australia recognized the need to adopt quality assurance systems as an important means of maintaining and increasing market access.

SQF Management Systems are designed:

- ☑ To raise food safety and quality standards across the food chain, from primary producer to consumer though increased awareness understanding and adoption of SQF Management Systems;
- ☑ To continuously improve and deliver high standards of customer service and support to SQF clients;
- ☑ To continue to pursue increased recognition of SQF management systems by customers and clients in new and existing markets;
- ☑ To maintain and protect the high level of integrity of SQF Quality Codes.

Developing SQF Systems

Those developing, documenting, validating and verifying SQF systems must be trained in HACCP and SQF systems registered with SQF as "SQF Practitioners" and have relevant food industry experience.

SQF Practitioners must complete a recognized HACCP training course. A number of HACCP training courses are licensed and courses are widely available. SQF Practitioners also undertake an SQF systems training course.

Auditors of SQF systems must be employed by certification bodies licensed by the SQF Program and the Certification Bodies must be accredited under the guidelines of the International Accreditation Forum.

SQF Auditing has been aligned to IAF guides 62/65. It includes a desk or documentation audit, certification audit and subsequent maintenance audits through which conformance to HACCP are verified. A re-certification audit is required every three years to re-validate the quality system.

On attaining SQF certification a distinctive certification trademark can be applied to the product to inform consumers that the food or fibre carrying the mark has been supplied by an SQF certified company. The certification mark can also be applied to stationary, vehicles, uniforms etc. Conditions for the use of marks are explained in a separate document.

The certified businesses range along food and fibre supply chains from raw material suppliers and service contractors, through producers, food processors and manufacturers, transporters, hotels and resorts, to airline and institutional caterers.

SQF brings value to a company as:

- The enabling tool for producers, manufacturers and distributors who need to demonstrate “due diligence “and traceability;
- A proven method for supply chain stakeholders (producers through to retailers) to increase market share and profits by aligning products and services to meet consumer requirements;
- A means of building consumer confidence and trust;
- An internationally recognized standard, suitable for all food suppliers operating in domestic and global markets; and
- A management system that allows the implementation of operational efficiencies.

Customers can have greater confidence in the safety, quality and consistency of the food supplied by an SQF certified system.

Broad acre cropping systems and livestock production merchants generally purchase produce from quality assured producers prior to harvest. Importers prefer quality assured product.

☑ Banks are more inclined to lend money to business that has implemented management systems to address customer needs;

☑ Industry is able to fast track solutions to problems because quality assured growers maintain records that assist in problem solving activities. Through the HACCP risk management approach, industry is better able to direct research and development funds to areas of greatest need; and

☑ Governments can acknowledge that those businesses in a third party audited HACCP based system are responsible. They are able to reduce their surveillance of these businesses and are in turn are better placed to direct their limited resources to other problem areas.

Responsibility for food safety and quality will continue to be promoted through the food supply chain. All stakeholders in this chain will be required to share responsibility for the integrity of the food supply. Those that do not, will be considered unreliable and are likely to fall by the wayside.

People and businesses that produce, manufacture, store, transport and retail the food we eat, accept and acknowledge their individual responsibilities. However, running a business can involve managing other issues such as worker safety, animal welfare, environmental factors and many others. It also involves making a profit. It is therefore imperative that systems are available to provide the integrity of supply that is essential for consumer confidence, whilst at the same time contributing to the viability of the food industry. The SQF Codes are designed to fulfil this requirement.

The SQF program is now rapidly embracing global expansion. Segments of the food sector worldwide have recognized that the system, initially intended for West Australian food and fibre producers, is as a tool that can provide the world with a method for assuring both food and safety and quality.

SQF 1000 Code

The SQF 1000 Code or Quality code was developed in 1999 in response to the demand for a simple HACCP-based approved supplier food safety system for primary producers. It was specifically developed for the primary sector as a food safety and quality standard.

Contents of the SQF 1000 code:

- Preface
- Contents
- Introduction
- Scope
- References
- Definitions
- SQF 1000 System requirements
    - Commitment
    - Suppliers
    - Control of production
    - Verification
    - Document control and Records
    - Product Identification, Trace and recall
- Appendix 1 Implementing SQF systems
- Appendix 2 Principles & application of HACCP
- Appendix 3 Certifying SQF 1000 systems
- Appendix 4 SQF 1000 Certification Trade Mark & Rules for use

Levels of Certification

The SQF code is divided into three certification levels. Each level is designed to indicate the stage of development of the producer's food safety and quality management. A producer can choose a level that is acceptable to a customer and the attainment of a level indicates the stage of development of the producer's SQF System. The three SQF 1000 certificate levels are:

☑ Level 1 *Food safety fundamentals* indicate that prerequisite programs and fundamental food safety controls have been implemented to provide a sound foundation for the further development of the producer's management system.

☑ Level 2 *Accredited HACCP based food safety plans* incorporates all level 1 system requirements and indicates that a food safety risk analysis of the crop, its production and harvest been completed to identify the hazards and the action taken to eliminate, prevent or reduce their occurrence. Level 1 certification is a prerequisite to gaining a level 2 SQF 1000 certificate.

☑ Level 3 *Comprehensive quality management systems development* incorporates all level 1 and level 2 system requirements and indicates that a food quality risk analysis of the product and its associated process has been completed, that the action taken to prevent the incidence of poor quality has been implemented and the remaining quality management system procedures have been implemented. Level 1 and level 2 certification are prerequisites to gaining level 3 SQF 1000 certification.

The Food Marketing Institute (FMI)

The SQF Program is owned by the Food Marketing Institute (FMI). At the request of its retail members, SQF was acquired by FMI, the objective being to use a single program which increased supplier efficiency. SQF is recognized by the Global Food Safety Initiative as conforming to the highest international standards and utilizes protocols recognized by the International Accreditation Forum.

The SQF program has been implemented by over 4,000 companies operating in the Asia-Pacific Region, the Middle East, the United States, Europe and South America. Registered SQF Experts and SQF Auditors are implementing and auditing SQF systems around the world. The SQF Institute is a Division established by the FMI to manage SQF Programs. An FMI advisory board provides overall policy advice, guidance and direction to that institute.

The Technical Committee, a team of food safety and quality specialists, reviews the SQF Program and recommends improvements to the Codes, the training materials and implementation, audit and certification requirements. The SQF 1000 Code is a CIES benchmarked standard.

Useful Website: http://www.sqfi.com.

EUREP – EURO-RETAILER PRODUCE WORKING GROUP

The objective of the EUREP (Euro-Retailer Produce Working Group), which consists of leading European food-retailers, is to raise standards for the production of fresh fruit and vegetables. In November 1997 the first draft protocol for Good Agricultural Practice was agreed to. This represented the first step toward integrated production. In September 1998 the EUREP initiated pilot trial projects to verify the implementation of EUREP-GAP in the field.

The draft protocol has been subject to numerous revisions. Representatives from around the globe and all stages of the food chain have been involved in the development of these protocols. In addition the views from stakeholders outside of the industry including consumer and environmental organizations and governments have helped shape the protocols. This wide consultation has produced a robust and challenging but nonetheless achievable protocol which farmers around the world can use to demonstrate compliance with Good Agricultural Practices.

Technically speaking EUREP-GAP consists of a set of normative documents that are suitable for accreditation to internationally recognized certification criteria such as ISO Guide 65. In addition to the standard for the production of fresh fruit and vegetables, standards have been developed for flowers and ornamentals, integrated farm assurance, integrated aqua assurances and (green) coffee. The standards are widely available and are accessible through the EUREP-GAP website: www.eurep.org.

Scope of the Standard for the Production of Fresh Fruits and Vegetables

The document sets out a framework for Good Agricultural Practice (GAP) on farms. This framework defines essential elements for the development of best-practices for the global production of horticultural products (e.g., fruits, vegetables, potatoes, salads, cut flowers and nursery stock). It defines the minimum standards acceptable to leading retail groups in Europe. Standards of individual retailers and those adopted by some growers may, however, exceed those described. The document does not set out to provide prescriptive guidance on every method of agricultural production.

EUREP members wish to recognize the significant progress made by many growers, grower groups, grower organizations, local schemes and national schemes in developing and implementing best-practice agricultural systems with the aim of minimizing adverse impact on the environment.

EUREP members also wish to encourage further work to improve growers' capability in this area, and in this respect this GAP framework, which defines the key elements of current agricultural best-practice, should be used as a benchmark to assess current practice, and provide guidance for further development.

GAP is a means of incorporating Integrated Pest Management (IPM) and Integrated Crop Management (ICM) practices within the framework of commercial agricultural production. Adoption of IPM/ICM is regarded by EUREP members as essential for the long-term improvement and sustainability of agricultural production. In response to the challenges posed by fast changing Crop Protection Product legislation, the EUREP-GAP Technical and Standards Committee developed guidance notes to help farmers and growers to become more fully aware of the Maximum Residue Limits (MRLs) in operation in the markets where the product will be sold. The changes have been introduced so that growers develop awareness of the MRLs in operation in the countries where the product will be or is likely to be sold. It is important that growers can demonstrate that their produce meets the MRL requirements of these countries, particularly if the regimes are stricter than those in the country of production. EUREP-GAP stresses the importance of residue screening and provides further re-assurance where the exact destination of the product is not known. EUREP-GAP also produced a list of contacts where growers can find the most up-to-date information concerning MRLs. This will help growers to meet the challenges posed by legislative requirements. This list is available on the website of EUREP-GAP.

EUREP supports the principles of and encourages the use of HACCP (Hazard Analysis Critical Control Points).

Commitment

It is essential that all organizations involved in the food production chain accept their share of the tasks and responsibilities to ensure that GAP is fully implemented and supported. If consumer confidence in fresh produce is to be maintained, such standards of Good Agricultural Practice must be adopted, and examples of poor practice must be eliminated from the industry. All growers must demonstrate their compliance with national or international law.

All growers should be able to demonstrate their commitment to:

a) maintaining consumer confidence in food quality and safety;
b) minimizing detrimental impact on the environment, whilst conserving nature and wildlife;
c) reducing the use of agrochemicals;
d) improving the efficiency of natural resource use; and
e) ensuring a responsible attitude towards worker health and safety.

Contents of the EUREP-GAP Document

The EUREP-GAP document includes the following, with subsequent conditions:

Introduction
1. Traceability
2. Record Keeping and Internal Self-inspection
3. Varieties and Rootstocks

4. Site History and Site Management
5. Soil and Substrate Management
6. Fertilizer Usage
7. Irrigation/Fertigation
8. Crop Protection
9. Harvesting
10. Produce Handling including Postharvest Treatments
11. Waste and Pollution Management, Recycling and Re-use
12. Worker Health, Safety and Welfare
13. Environmental Issues
14. Complaint Form

The EUREP-GAP standard pays specific attention to waste and pollution management, recycling and re-use, Worker Health, Safety and Welfare, environmental issues anticipated to the present retailers and consumer demands.

Certification of EUREP-GAP

Growers receive their EUREP-GAP approval through independent auditing from a verification body that is approved by EUREP-GAP.

Documents included in the scheme include:

1) "EUREP-GAP General Regulations for Fruits and Vegetables," explains the structure to certification to EUREP-GAP standards for Fruits and Vegetables and the procedure that should be followed in order to obtain and maintain certification (version 2.1 January 04);
2) EUREP-GAP Document "Control Points and Compliance Criteria Protocol for Fruits & Vegetables" is the standard with which the farmer must comply and which gives specific details on how the farmer complies with each of the requirements of the scheme (latest version; 2.1 October 2004);
3) EUREP-GAP Checklist Fruits and Vegetables which forms the basis of the farmer external audit and which the farmer must use to fulfil the annual internal audit requirements (latest version; 2.1 of October 2004).

Benchmarking GFSI

As of date, EUREP-GAP standards have not been benchmarked by the GFSI. Discussions are, however, on the way.

Useful website: www.eurep.org

HAZARD ANALYSIS AND CRITICAL CONTROL POINT (HACCP)

The Hazard Analysis Critical Control Point (HACCP) System was introduced in the United States (US) in 1971 by the Pillsbury Company in collaboration with the National Aeronautics and Space Administration (NASA) and the U.S. Army Natick Research & Development Laboratories. These agencies had the initial responsibility of designing and manufacturing food products and hardware which were to provide 100% assurance that either the food products would not be contaminated with pathogen, bacteria or viruses which could cause illness or that the equipment would function with zero defects.

After extensive evaluation, it was decided that the only way success could be achieved was by exercising control over the process and the workers, beginning as early as possible in the production system. This preventative system was perceived to offer the highest degree of assurance that the products manufactured were safe as it negated the need for any further end product testing, and emphasis was placed on monitoring. The HACCP concept for food safety was developed on the basis of this approach.

HACCP Internationalization, Concept, Purpose, Implementation and Benefits

The HACCP system has become the internationally recognized system for the management of food safety for all companies involved in the production, transformation, storage and distribution of food for human consumption.

The *HACCP concept* involves the identification of specific hazards throughout the entire processing chain and focuses on preventative measures for their control to assure the quality and safety of the food. This includes analysis of raw material sources and usage, processing equipment, operating practices, packaging and storage, together with marketing and conditions for intended use. There is less reliance on the traditional system of end product testing and food safety is built into the product from conception through design and distribution.

The *purpose of HACCP* can therefore be summarized as follows: "to identify potential problems which could occur in an operation, consider each and establish controls to minimize or prevent its occurrence".

Implementation of a HACCP System

The HACCP concept is based on 7 principles and 12 steps.

The CODEX Alimentarius describes 12 steps:

1. Assemble the HACCP team
2. Describe the product
3. Identify the intended use
4. Construct flow charts
5. On-site verification of flow chart
6. List all hazards associated with each step and list preventive measures
7. Apply HACCP decision on each hazard
8. Establish target levels and tolerances for each CCP
9. Establish a monitoring system for each CCP
10. Establish corrective actions
11. Verification of the system
12. Establish record keeping and documentation

(Note**:** Point 6 up to and including 12 are the so-called 7 principles of the HACCP process.)

Benefits of a HACCP System

Some benefits of the HACCP-concept for general purposes and for food inspection include:

- The system is preventive, pro active, systematic, scientific and cost effective;
- It is a management tool;
- The system is internationally acknowledged (FAO/WHO);
- The system is applicable throughout the food chain;
- The system leads to increased awareness and subsequent greater involvement and commitment of employees;
- The official control based on HACCP-programs is more efficient than traditional inspection or end product-testing alone. Hence, health protection of consumers is enhanced;
- Harmonization of food inspection practices at an international level;
- Facilitation of Regulatory/Customer inspection;

- It leads to greater confidence in product safety;
- The system takes a preventive approach; reduction of rework and losses are achieved. Subsequently reduction of cost is achieved.

Certification of HACCP

Different countries apply different criteria for auditing and assessing implemented HACCP systems.

A guideline titled: Guidance on Regulatory Assessment of HACCP, was jointly published by FAO and WHO. This document was the output of an FAO/WHO Consultation on the Role of Government Agencies in Assessing HACCP, convened in Geneva in June 1998. Standards have been established in a number of countries on the basis of these guidelines.

Certification is carried out by a company accredited by the Board of Accreditation. A successful audit will result in a certificate**.** The certificate is not guaranteed for a life time. Repeat audits by the same certifying body will be carried out at 3-year intervals, following which a new application must be made for certification. Certification is not a legal requirement; it can be pursued owing to company policy or can be requested by wholesale companies.

Differences in the requirements of individual countries lead to differences in the level of HACCP systems. HACCP requirements and HACCP criteria differ greatly across countries. Experience acquired on HACCP implementation differs substantially given the different levels of experience and knowledge of auditors. Various levels of certified HACCP systems therefore exist.

ISO 22000: FOOD SAFETY MANAGEMENT

ISO 22000

ISO is currently working under the Technical Program TC 34 on various new documents: ISO 22000: Food safety management – Requirements for any organization in the food chain. This document emphasizes certification requirements for HACCP and will further contribute to the standardization and harmonization of HACCP systems worldwide.

Why ISO 22000?

HACCP standards have been developed in many countries:

- The Indian Standard: Food hygiene – Hazard Analysis and Critical Control Points (HACCP) System and guidelines for its application: IS 15000:1998, is applied in India;
- The Singapore Standard 444 is applied in Singapore;
- SABS 0330: Code of Practice for the implementation of a HACCP system is applied in South Africa;
- Requirements for a HACCP based Food safety System version September 2002 is applied in the Netherlands;
- National Standard of Ukraine 4161-2003 Food Safety Management System is applied in Ukraine;
- Turkish Standard TS 13001 (March 2003) is applied in Turkey.

These standards vary widely with different levels of auditing. HACCP certification therefore varies considerably.

ISO 22000 has been specifically developed to harmonize all of those standards. ISO 22000 is in the final stage of preparation. It is expected that the document will be officially available in September 2005.

ISO 22000 specifies requirements for a food safety management system where an organization in the food chain needs to demonstrate its ability to control food safety hazards in order to ensure that food is safe at the time of human consumption.

It is applicable to all organizations, regardless of size, which are involved in any aspect of the food chain and that wish to implement systems that consistently provide safe products. Meeting requirements of ISO 22000 can be accomplished through the use of internal and/or external resources.

ISO 22000 specifies requirements to enable an organization:

- ☑ To plan, implement, operate, maintain and update a food safety management system aimed at providing products that, according to their intended use, are safe for the consumer;
- ☑ To demonstrate compliance with applicable statutory and regulatory food safety requirements;
- ☑ To evaluate and assess customer requirements and demonstrate conformity with those mutually agreed customer requirements that relate to food safety in order to enhance customer satisfaction;
- ☑ To effectively communicate food safety issues to their suppliers, customers and relevant interested parties in the food chain;
- ☑ To ensure that the organization conforms to its stated food safety policy;
- ☑ To demonstrate such conformity to relevant interested parties; and
- ☑ To seek certification or registration of its food safety management system by an external organization, or make a self-assessment or self-declaration of conformity to ISO 22000.

Deliverables of ISO 22000

- The standard can be used as the basis of any food safety management system, with or without 3rd party certification.
- The standard includes requirements for addressing (assessing and implementing) food safety concerns of customers (e.g., retailers) and regulators.
- Prerequisite programs (Hygiene and GMP)
- HACCP (Hazard Analysis and Critical Control Point)
- System management (ISO 9000 approach)
- Interactive communication along the food chains

Key Paragraphs of ISO 22000

- Documentation requirements
- Management responsibility
- Resource management
- Planning and realization of safe products
- Verification, validation and improvement of the Food Safety Management system

ISO 22000 knows the following procedures which shall be documented:

1. Documentation
2. Records
3. Corrections
4. Non Conformities
5. Recall (which includes traceability)
6. Internal Auditing

Prerequisites programs (personnel hygiene, cleaning and sanitation, pest control, measures for the prevention of cross contamination, packaging procedures and the management of purchased raw materials, ingredients, chemicals, utilities or supplies such as steam, water and ice, disposal of waste and sewage and handling of products (e.g., storage and transportation) should be documented.

The ISO 22000 is expected to be available during the final quarter of 2005.

ISO 22000 consist of a series of documents. A guidance document ISO 2200x, a Handbook for SME's (ISO 2200x) and Guidelines for Certification (ISO 2200x).

Other ISO Documents

Another document under preparation is the **ISO/CD 22519** "Traceability in the Feed and Food Chain – General Principles and Guidance for System Design and Development." The standard provides recommendations for the implementation of a traceability system. The standard specifies the principles and the requirements for the design, development and implementation of a feed and food traceability system. It can be applied to the whole or part of the food chain.

It is a technical tool which can be applied for compliance with specific regulations and/or other defined objectives. It can be applied as necessary to document the history, application or location of a product or of the relevant component(s). It is intended to be flexible enough to allow for organizations to use it to achieve the specific identified objectives.

CD means Committee Draft which means that the document is still under development and subject to changes.

The *ISO 9001:2000 Standard* can be applied to the Food Industry. It is, however, not commonly applied as a single system for the Food industry. It is recommended that this standard is used together with and after HACCP implementation if a complete Quality Management System is to be attained. Neither a single HACCP certificate nor a single ISO 9001:2000 certificate is enough. They must have shared components.

The *ISO 15161:2001 Standard* provides guidelines on the application of ISO 9001:2000 to the food and drink industry. This guideline is based on the ISO 9001:2000 guideline and includes HACCP. This standard is not, however, designed for certification. It is not an auditable standard but rather a tool for the food industry to implement ISO in combination with HACCP.

Useful website: www.iso.org

THE FOOD BUSINESS FORUM (CIES)

The Food Business Forum – is the only independent global food business network. It serves the CEOs and senior management of 175 retailer and 175 supplier member companies and their subsidiaries in over 150 countries. CIES retailer members alone generate over USD2,000 billion, employ 4.5 million people and operate close to 600,000 stores representing a total sales area of 160 million square meters. CIES has been growing with the food business for over 50 years. Its strength lies in the active commitment of its member companies and its privileged access to key industry players. With its headquarters in Paris and its regional offices in Washington, Singapore and Tokyo, CIES serves its members throughout the world.

The CIES is a unique, truly international food business network, which is strategically placed at the interface between retailers and suppliers. Membership in the CIES is on a company basis and includes more than two thirds of the world's largest food retailers and their suppliers. At the same time, local players from Austria to China and New Zealand to Brazil also play an active role in the organization.

Activities of the CIES are designed for chief executives, corporate managers and main function directors. CIES programs include international congresses, conferences and "modules" as well as smaller meetings which deal with specific topics in great depth. These programs cover thematic areas such as strategic management, food safety, the image of the food retail sector, and functional areas such as marketing, information technology and supply chain management.

The programs include projects, international conferences and seminars, benchmarking studies, publications and reports, as well as many other tailor-made member services. Special programs and initiatives such as the Global Food Safety Initiative created in May 2000 or the Supply Chain Benchmarking Project "Glosup" complete the large spectrum of activities undertaken by the organization.

The CIES network is based on privileged access to information and contacts. It enables members to step back from daily business life and take in the latest trends and developments in the global food business. By sharing this knowledge, CIES members gain a new perspective on their activities which brings a key advantage in their business. Membership benefits can be checked out to learn more about the value added by the CIES to a company.

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GLOBAL FOOD SAFETY INITIATIVE (GFSI)

GFSI has facilitated the initiative to enhance food safety, ensure consumer protection, strengthen consumer confidence, set requirements for food safety schemes and improve cost efficiency throughout the food supply chain.

Following their lead, the Global Food Safety Initiative (GFSI) was launched in May 2000. The Initiative is facilitated by CIES – The Food Business Forum. It is based on the principle that food safety is a non-competitive issue, as any potential problem arising may cause repercussions in the whole sector.

Key priorities of the Initiative are:

- To implement a scheme to benchmark food safety standards world-wide
- To build and implement an international early warning system
- To encourage co-operation between the world-wide food sector and national and pan-national governments and authorities
- To coordinate Good Retailing Practices

An international task force was formed soon after the launch of the Initiative to work on these priorities.

Benchmarking Food Safety Standards

In the light of the plethora of food safety standards, a decision was taken by the task force, not to write a new standard. Instead, a set of 'key elements' was compiled to serve as the requirement against which existing food safety standards will be benchmarked. The 'key

elements' as defined by the Task Force are:
- Food Safety Management Systems
- Good Practices for Agriculture, Manufacturing and Distribution
- HACCP (Hazard Analysis and Critical Control Points)

A study of ISO standards and related Codes of Practice, which took into account a background of recent consumer health and safety concerns, was undertaken in order to link these requirements to Codex Alimentarius and legislative requirements.

The conforming benchmarked food safety standards can be applied by food suppliers throughout the supply chain, upon agreement with retailers, when defining contracts for sourcing of products. The application of the benchmarked standards to particular products will be at the discretion of retailers and suppliers. This process will vary in different parts of the world, depending on:
- company policies;
- general regulatory requirements; and
- product liability and due diligence regulations.

The use of benchmarked standards on a global scale will also be of importance for developing countries and their consumers. Greater efficiency from field to fork will be pursued in these regions as well, due to increased awareness and harmonization of standards which have been reviewed by the Task Force.

Retailers and suppliers will also benefit through this harmonization as inspections will be conducted in the local language enabling the auditor to challenge systems more effectively. Suppliers will be more equitably treated globally, and will not be penalized for the location of their site. In addition, the GFSI benchmark system will allow a larger number of suppliers to have third party audits, reducing travel expenses for retailers and suppliers thereby allowing them to redirect their resources to other food safety activities.

Benchmarked Standards

As a result of the work of the Task Force, The Global Food Safety Initiative has benchmarked four standards in compliance with the 4th Edition of the Guidance Document containing requirements for Food safety schemes for the Food Industry:
1. The BRC standard
2. The Dutch HACCP Code
3. The SQF 2000 Code
4. The International Standard for Auditing Food Suppliers (International Food Standard, IFS)

Benchmarking of farm assurance standards for agricultural produce, commenced this year (2005). One standard has been benchmarked to date, and has been found compliant with the 4th edition of the GFSI guidance document.
- The SQF 1000 Code

Useful website: www.ciesnet.com

LABELING

Minimum Labeling Requirements

The provisions of relevance to marking are as follows: each package must bear the following particulars in letters grouped on the same side, legibly and indelibly marked and visible from the outside:

a) The nature of the produce: indication of type-variety, where the contents of the package are not visible from the outside;
b) Identification: packer and/or dispatcher: name and address of officially issued or accepted code mark;
c) Origin of the produce: Country of origin and optionally, district where grown or national regional or local place name;
d) Commercial specification, e.g., class, weight, net quantity or number of pieces or units.

For detailed information on labeling, refer to the document EC Marketing Standards for Fresh Fruits, Vegetables, Salad Crops and Nuts, a retailer's guide of the DEFRA which is accessible on their website**.** DEFRA is the Department for Environment, Food & Rural Affairs in the UK.

Useful website: http://www.defra.gov.uk and www.cbi.nl/accessguide

EU Legislation and EU Standards

The marketing standards for quality and labeling of fruits and vegetables are laid down in EC 2200/96. A detailed description of standards can be obtained from the Horticultural Marketing Inspectorate (HMI), an Inspectorate within the Department for Environment, Food & Rural Affairs in the UK. (DEFRA).

Useful website: http://www.defra.gov.uk/hort/hmi.htm. and www.cbi.nl/accessguide

APPLICATION OF MANAGEMENT TOOLS FOR BETTER FOOD QUALITY AND SAFETY

Application of Management Tools

A systematic approach must be taken to the application of management tools for improving food quality and safety. Management tools that may be applied for the achievement of food quality and safety include:

- Food Quality and Safety systems as described above;
- Quality and safety parameters such as FSO's (Food Safety Objectives) or KPI's (Key Performance Indicators). FSO's and KPI's are basically the same, although FSO's specifically cover food safety issues such as consumer complaints, non conformance reports, waste, verification results of analysis of products, internal audits, recall, calibration, etc. Continuous improvement must be demonstrated and communicated.

Additional Market Requirements as Management Tools

Although not directly related to quality and safety, producers are confronted with additional requirements in order to conform to marketing and consumer requirements. Information pertinent to social conditions, such as social market requirements focused on labor standards (SA 8000), fair price policy (e.g., Fair Trade) and environmental market requirements focusing on environmental-friendly production (ISO 14000) or organic production at production sites is required from producers, by the EU.

Social Accountability 8000 (SA 8000) is a universal management system for companies seeking to guarantee the basic rights of their workers. The standard is applicable to all industries and is based on internationally accepted ILO Conventions. It was initiated with the certification of toy manufacturers, garment manufacturers, manufacturers of plastics and manufacturers of pharmaceuticals, and now has a growing number of companies worldwide.

Website (CBI) www.cbi.nl and www.cbi.nl/accessguide.

CAPACITY BUILDING FOR BETTER MANAGEMENT

Food and Agriculture Organization

The ultimate resource in capacity building for better management in the area of agricultural produce is the Food Agriculture Organization (FAO). FAO's website, (www.fao.org) provides a considerable volume of useful information ftp://ftp.fao.org/es/esn/food/manualfruits_en.pdf.

FAO has recently prepared a trainers manual titled "Improving the safety and quality of fresh fruits and vegetable; a practical approach." This manual for trainers was prepared by Maya Piniero and Luz Berania Diaz Rios of the Food Quality and Standards Service Food and Nutrition Division FAO. Other publications of FAO include "Handling and processing of organic fruits and vegetables in developing countries" 2002, etc.

Other

EUREP-GAP and SQF provide extensive training programs which can found on their respective websites.

Details of SQF training courses can be found in the document SQF SYSTEMS TRAINING: Criteria for SQF training centers and training courses. In addition to pre requisite course requirements, the document outlines training course requirements for the SQF Systems Training Course – Implementing SQF Systems and Auditing SQF Systems and Course assessment for the same subjects. www.sqfi.org

In June 2005, EUREP-GAP launched a document titled "Training regulations all scopes" for train the trainers programs for EUREP-GAP (www.eurep.org).

DISCUSSION AND CONCLUSION

SQF is a benchmarked standard for agricultural and horticultural produce, implemented by the GFSI. The SQF 1000 Code is a Food Quality and Safety system widely known in the Far East, North America, Middle East and South Africa. EUREP-GAP is more widely known in Europe. EUREP-GAP certified products from Africa, India, and Malaysia etc. find their way to Europe. As of date, EUREP-GAP is not yet a GFSI benchmarked standard. It is a business to business standard.

The GFSI has benchmarked four standards for the food industry in compliance with the 4th edition of their Guidance document: 1) the BRC standard, 2) the Dutch HACCP Code, 3) The SQF 2000 Code, and 4) the International Standard for Auditing Food Suppliers (International Food Standard, IFS). The SQF 1000 Code is currently the only benchmarked standard for the Primary sector.

HACCP certification is characterized by the application of individual national standards. HACCP certificates differ widely in their level and content.

The newly developed ISO 22000 will further enhance harmonization of HACCP standards and will provide a response to the large number of individual national HACCP standards. Although ISO 22000 was initially designed for the food processing industry it also covers the primary sector. It is highly recommended that developments of ISO 22000 are followed.

FAO is the ultimate resource for capacity building in quality and safety of fruits and vegetables. EUREP-GAP and SQF also provide training programs. Labeling is growing in importance given the increasing traceability requirements. Implementation and certification according to standards are management tools. KPI's or FSO's can be applied. Other market requirements such as social and environmental concerns should be considered. It is recommended that benchmarked standards of the GFSI are followed.

Certification based on standards and/or systems is a scheme of a third party assurance program whereby manufacturers of good and safe products are awarded with certificates. This exercise, which is basically voluntary, must be implemented by governments in order to encourage manufacturers to comply with set standards. In the food manufacturing sector, quality and safety of food is positively promoted through this scheme. The awards trigger health competition amongst manufacturers of similar food products. The resultant effect is compliance with legislation.

8. POSTHARVEST MANAGEMENT OF FRUITS AND VEGETABLES FOR BETTER FOOD QUALITY AND SAFETY

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INTRODUCTION

Significant quantities of horticultural crops are lost between harvest and consumption. The magnitude of these losses varies in accordance with the country and the commodity. In order to reduce these losses, postharvest technologies which delay senescence and which maintain quality must be applied. Existing technologies must be improved and alternative technologies must be sought. This paper focuses on the importance of fresh fruits and vegetables as food, and on the use of technologies for improving the quality and safety of horticultural commodities.

IMPORTANCE OF FRUITS, NUTS AND VEGETABLES IN HUMAN NUTRITION AND HEALTH

Fruits and vegetables contribute approximately 91% of vitamin C, 48% of vitamin A, 27% of vitamin B6, 17% of niacin, 16% of magnesium, 19% of iron and 9% of calories to the human diet. Other important nutrients supplied by fruits and vegetables, include folacin, riboflavin, zinc, calcium, potassium and phosphorus (24).

Fruit and vegetable consumption has increased in response to growing health consciousness. Their consumption has been strongly linked do reduced risk of some forms of cancer, heart disease, stroke and other chronic diseases (15, 23, 25). Fruits and vegetables are sources of antioxidants which modify the metabolic activation and detoxification/disposal of carcinogens, or even influence processes that alter the course of tumor cell growth (25). Although antioxidant capacity varies greatly among fruits and vegetables, consumption of a variety of fruits and vegetables is preferred, over limiting fruit and vegetable consumption to those having the highest antioxidant capacity (15).

REDUCTION OF QUANTITATIVE AND QUALITATIVE LOSSES DUE TO CHILLING INJURY

Chilling injury occurs in some horticultural commodities (mainly those of tropical and subtropical origin) when maintained at temperatures above their freezing point, and below 5°C to 15°C, depending on the commodity (8). Some examples of chilling-sensitive produce includes apples (*Malus domestica*, Borkh.), asparagus (*Asparagus officinallis*, L.), avocados (*Persea Americana*, Mill), beans (*Phaseolus* spp.), bananas, various species of citrus, cucumbers (*Cucumis sativus*, L.), eggplants (*Solanum melongena*, L.), mangoes (*Mangifera indica,* L.), melons, nectarines, papayas (*Carica papaya* L.), peaches, peppers (*Capsicum annum* L.), pineapples (*Ananas comosus*, (L.) Merrill), plums, pomegranates (Punica granatum, L.), some cultivars of potatoes, pumpkins and numerous ornamentals.

A few techniques have been successful in circumventing chilling injury. Intermittent warming has been most successful for peaches, nectarines and pomegranates (1, 13), and temperature conditioning has been successful for grapefruits and pomegranates.

REPLACEMENT OF CHEMICALS USED FOR THE CONTROL OF PHYSIOLOGICAL DISORDERS, DECAY AND INSECT INFESTATION

Growing consumer awareness of the potential harm of chemical treatments for the control of insects, diseases and physiological disorders, has led to the development of non-damaging physical treatments for this purpose in horticultural produce. Methods employed for high temperature treatment and their effects on treated produce, on pathogens and on insects associated with the produce will be discussed here.

Heat Treatments

Hot Water Dips

Hot water treatments were originally used for fungal control. Their use has, however, been extended to curing and insect disinfestations. Postharvest hot-water dips are often applied for a few minutes in order to control decay.

The use of warm water dips has been tested on sweet lime fruits. Fruit were wounded and inoculated with spores of *Penicillium intalicum*, following which they were retained at room temperature for 4–5 h and subsequently dipped in warm water at 25, 45 and 55°C for 2 and 5 minutes. Dipping in warm water at 25 and 45°C for 5 minutes was observed to significantly reduce decay during storage (12).

Procedures for hot water dipping for the disinfestations of a number of tropical and sub-tropical fruits from various species of fruity fly have also been developed (11).

Hot Air Treatments

Hot air can be applied by either placing the produce in heated chambers equipped with a ventilating fan or through the forced application. The Indian meal moth, *Plodia interpunctella* which is a major pest in dry fig storage, can be satisfactorily controlled by packaging figs in plastic bags having a thickness of 0.24 mm, after suitable temperature treatment. Hot air treatments at 60°C for at least 7 hours, or at 65°C for at least 6 hours, were effective in controlling pest infestation without affecting fruit quality (19).

Hot air can also decrease fungal infections. Hot air treatment was observed to reduce decay caused by *Botyris cinerea* Pers. Fr. and *Penicillium expansum* Link., in apples (6,10) and *Penicillium digitatum* in mandarin (14).

EXTENDING THE STORAGE LIFE OF FRUITS AND VEGETABLES

Fruit Ripening

Ripening of most climacteric fruits is characterized by softening of the flesh, an increase in the sugar to acid ration, enhanced color development and increasing respiratory activity and ethylene production.

Inhibition of ripening by heat, may be mediated by its effect on the ripening hormone, ethylene. Heat treatment inhibits ethylene synthesis within hours in both apples and tomatoes (5, 9). During the heating process, not only is the production of endogenous ethylene inhibited, but fruits will not respond to the exogenous application of ethylene (22, 26). This indicates either a loss or the inactivation of ethylene receptors, or the inability to transfer the signal required to initiate the subsequent series of events leading to ripening (11).

Heated fruits often soften at a much lower rate than do non-heated fruits. Red Delicious and Golden Delicious apples, showed a significant increase in firmness immediately after storage at 38°C for 4 days, or within one week of being retained at 20°C (17, 21).

Flavor characteristics of fruits can be affected by heat treatment. Quince fruits (*Cydonia oblanga* L.) which were heated for 36 hours at 38°C showed a significant increase in firmness, reduced astringency and higher ß-carotene content when compared with controls (16).

TREATMENTS TO MINIMIZE WATER LOSS

Postharvest studies have shown that reducing transpiration provides a means of extending the shelf-life of fresh produce. Water loss during transpiration leads to shrinkage, drying and softening and triggers senescence, leading to accelerated deterioration of produce. Waxing is commercially used to reduce the transpiration rate of fruits and vegetables. While it is, adequate for reducing transpiration rates, it is effective in restricting oxygen and carbon dioxide exchange, with the consequent development of alcohols, aldehydes and off flavors.

Sealing of fruits in plastic films of high-density polyethylene, results in marked resistance to water vapor loss. Individual seal packaging has been demonstrated to be practical for treating fruits and vegetables in a water-saturated environment (4). Films appear to be more effective than waxes for reducing transpiration and to not appear to have any deleterious effect on internal quality (4).

The effects of curing, fungicides and film packaging were investigated by inoculating Valencia oranges (*Citrus sinensis* L.) with *Penecillium intalicum Wehmer* spores. Individually sealed and/or containers lined with low density polyethylene film and cold storage markedly reduced weight loss of cured fruits, over fruit which were directly exposed to cold storage alone.

MODIFIED ATMOSPHERE STORAGE FOR USE DURING TRANSIT AND PACKAGING

Modified atmosphere packaging, also known as “maintain and preserve” technology is employed to maintain and preserve the quality of fruit for shipping and packing. Modifying the environment around fresh produce, can alter its rate of respiration and metabolism, and increase its commercial storage life. Modified atmospheres can be generated by either active or passive systems. In the passive system, respiring fruit, over time, self-generate an atmosphere of elevated carbon dioxide and reduced oxygen, while in the active system, desired end-point concentrations of oxygen and carbon dioxide are established by flushing the fruit with a desired mix of gases.

Development of a MAP system must integrated consideration for the type, thickness and method of fabrication of the film, package size, temperature, relative humidity, duration of storage, type, quantity and physiological stage of fruit and tolerance of fruit to the various gases.

FOOD SAFETY ASSURANCE

Over the past few years, food safety has become, and continues to be the number one concern of the fresh produce industry. Assuring food safety necessitates:

- Prevention of microbial contamination of fresh produce, rather than relying on corrective actions once contamination has occurred;
- Use of good agricultural and management practices by growers, packers and shippers, so as to minimize microbial food safety hazards in fresh produce;
- Assurance of the use of potable water in all fresh produce operations;
- Proper management of the use of animal manure in order to minimize the potential for microbial contamination of fresh produce;
- Worker hygiene and sanitation practices during production, harvesting, sorting, packaging and transportation;
- Research on how various postharvest handling treatments influence the survival of human pathogens on fresh produce.

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1. BANGLADESH

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INTRODUCTION

Agriculture plays a key role in the overall economic performance of Bangladesh, in terms of its contribution to GDP, as a major source of foreign exchange earnings, and in providing employment to about 65% of the country's population. Moreover, the livelihoods of 70% of the rural population in Bangladesh are dependent on agriculture. Agricultural research and development in Bangladesh has contributed tremendously to meeting the food requirements of Bangladesh's population of approximately 140 million.

Though considerable priority has been given to the production sector, relatively little priority has been given to the post-production sector. Postharvest management in Bangladesh, like in most developing countries of the region, is far from satisfactory. Losses resulting from inadequate handling, poor-storage, and improper distribution result in diminished returns to producers.

Postharvest management is pivotal in an agricultural country such as Bangladesh. Success in agricultural production and in marketing hinges upon proper postharvest handling, storage, and processing of cereals, oil seeds, legumes and horticultural crops. Current postharvest handling of these crops, however, presents a dismal picture. Traditional techniques which result in considerable deterioration of physical and nutritional quality are generally practiced by growers, traders and processors. Improvement of these age-old practices and development of new technologies through organized research and development efforts have now become essential in order to reduce the tremendous levels of postharvest losses in grains, and fruits and vegetables, so as to increase the supply for food from a limited land resource area and thereby strengthen the economy of the country.

Bangladesh produces a diversity of fruits and vegetables on a seasonal basis. Simultaneous harvesting often leads to a glut situation in the market and to reduced prices to farmers. Overcoming periodic gluts necessitates the preservation of fruits and vegetables. Market opportunities exist for processed foods such as dehydrated fruits, canned fruits and vegetables, frozen vegetables, pickled fruits and vegetables, mango pulp, pineapple concentrate, tomato ketchup and paste, fruit juices (mango, orange, pineapple), potato chips and other potato products, both in domestic and export markets. Global interest in herbal teas and in organic foods, also present potential market opportunities for Bangladesh. It is therefore necessary for Bangladesh to formulate professional and specific development plans in conjunction with various government initiatives to promote the establishment of agro-based processing industries in the country.

PRODUCTION OF FRUITS AND VEGETABLES IN BANGLADESH

Bangladesh produces a diversity of tropical fruits and vegetables. Some of the more commonly produced fruit include banana, mango, pineapple, jackfruit, papaya, melon, mandarin, bur, guava, citrus fruits including lemon and lime, sapota and litchi. Approximate flowering periods and approximate harvesting periods for some of these, as well as their annual average levels of production are summarized in Table 1.

Table 1. Flowering Period, Harvesting Period and Average Annual Production of Selected Fruits Produced in Bangladesh

Items	Approximate Flowering Period	Approximate Harvesting Period	Average Annual Production (thousand tons)
Banana	Throughout the year	Peak period December to February & September to October	650
Mango	February	Mid-April to Mid-June	250
Pineapple	February–March	May to July	160
Jack fruit	February–March	Mid-April to Mid-July	280
Papaya	Throughout the year	Early July to Early August	50
Melon	February–March	Mid-March to Mid-June	120
Litchi	February–March	Mid-May to Mid-June	20
Guava	March–May November–December	-	90
Others	-	-	50

Source: Agriculture statistics, Bangladesh Bureau of Statistics, 2002

A diversity of tropical vegetables is produced in Bangladesh. Common vegetables produced, include potato, bringal, cauliflower, cabbage, watergourd, pumpkin, tomato, radish, spinach, beans, patal, lady’s finger (okra), cucumber, karola (bitter gourd), puisak, jhinga, and arum. Planting and harvesting periods as well as the annual average production of some important vegetables are summarized in Table 2.

Table 2. Planting and Harvesting Seasons and Production of Selected Vegetables in Bangladesh

Items	Planting Season	Harvesting Period	Average Annual Production (thousand tons)
Potato	September–October	January to February and October to April	3,450
Brinjal	May–June October–Mid-November	October to April Late November to Mid-April	375
Cauli-flower	Late October–Mid-November	Early January to Early March	90

Cabbage	Late October–Mid-November	Early January to Early March	120
Watergourd	Mid-July to Early November	Early January to Early March	100
Pumpkin	March–May July–August	June to September and November to January	115
Tomato	Mid-August–Mid-November	Early December to Mid-January	110
Radish	Mid-August to Early October	Early January to Mid-February	200
Spinach	September to Mid-November	October to February	10
Beans	Late June to Early September	Late November to Mid-April	50
Patal (Pointed gourd)	Mid-August to Mid-October	Mid-January to June	40
0kra	Mid-April–Mid-June Mid-September to Mid-December	June to Mid-September and November to March	25
Cucumber	Mid-September to Mid-June Mid-September to Mid-October	Mid-January to Mid-September	25
Karola (Bitter gourd)	February–May	June to October	25
Aram	March–April	June to August	140
Other vegetables	-	-	215

Source: Agriculture statistics, Bangladesh Bureau of Statistics, 2002

VALUE OF FRUITS AND VEGETABLES AND THEIR POSTHARVEST LOSSES

Fruits and vegetables play a significant role in human nutrition, particularly as sources of vitamins, minerals, dietary fiber and antioxidants. Consumption of a variety of fruits and vegetables on a daily basis is highly recommended because of associated health benefits, which include reduced risk of some forms of cancer, heart disease, stroke and other chronic diseases.

Both quantitative and qualitative losses occur in fruits and vegetables between harvest and consumption. Qualitative losses such as loss in edibility, nutritional quality, caloric value and consumer acceptability of fresh produce, are much more difficult to assess than are quantitative losses. Postharvest losses vary greatly across commodity types, with the location of production and with the season of production.

Postharvest losses in food grains in Bangladesh are reported at an estimated 15%, while in fruits and vegetables they are estimated at 20–25%. For highly perishable fruits and vegetables, these losses may go as high as 40%. The problem of postharvest losses is compounded by the lack of proper processing, preservation and storage systems. The absence of a well-developed marketing network and rapid transportation in the country also contributes significantly to high postharvest losses in fruits and vegetables.

Processing technologies have been developed for a few fruits, while a number of processing technologies are still under development. Potatoes and tomatoes are the only vegetables that are processed. Given the high perishability of fruits and vegetables and the absence of proper processing and storage facilities, there is wide price variation along the producer-consumer chain.

CURRENT MARKETING CHANNELS

Fruits and vegetables are marketed primarily in the fresh form. Produce is prepared for market either in the field or at the packing house. Preparation involves cleaning, sanitizing and storage according to quality and size, and where appropriate, treatment with a fungicide prior to packaging and marketing. Packaging protects the produce from mechanical injury and contamination during marketing. Fruit jams, jellies, juices, vegetable pickles and ketchup etc. are the main processed products produced in Bangladesh. These products are consumed on the domestic market. Small quantities of fresh fruits and vegetables are also exported. The Agricultural Marketing Company Ltd. (AMCL) in Bangladesh recently began exporting processed fruit and vegetable products.

Produce in rural areas is sold either to commission agents or to wholesalers in nearby markets. These wholesalers then sell the produce either to local retailers and major buyers or to exporters. The major share of the profit goes to the middleman. Market information systems do not exist. A co-operative marketing infrastructure is also lacking. Centralized grading, packing, transit storage facilities, transportation and bulk storage facilities are greatly lacking.

Corrugated fiberboard containers are commonly used for the packaging of produce, although reusable plastic containers are also increasingly being used. Fruits are generally transported to distant markets by truck in order to enhance efficiency and to reduce cost. Railway transportation is also used in some cases. High freight rates and damage during transit are some of the difficulties of transportation by air. Refrigerated transport is not available, as the fruit industry is not well developed owing to the lack of interest of traders and of the government.

FRUITS AND VEGETABLE PROCESSING INDUSTRIES IN BANGLADESH

The fruits and vegetable processing industry in Bangladesh is relatively poorly developed. Canning of fruits and vegetables has only recently begun. Commercial fruit and vegetables processing factories are owned by the private sector, and may be categorized as being either cottage, small, medium or large. Only the medium and large factories are fully mechanized. Bottled and canned products are generally produced in larger mechanized operations. Other factories produce jams, jellies, squashes, ready-to-serve beverages, ketchup and pickles.

(i) Factories are primarily engaged in the processing of mangoes, pineapples, oranges, and some other exotic fruits. In some cases processed products are prepared from fruit flavors and emulsions, rather than from fresh fruits. Despite the bright prospects for processing indigenous fruits and vegetables, these commodities are not utilized in processing.

(ii) Many of the fruit and vegetable processing industries in Bangladesh do not have effective quality control systems. With the exception of a few, the factories do not produce quality products. They do not maintain minimum standards of quality and food safety. Most of the cottage and small food processing operations employ poor hygienic practices. Staff employed in these processing operations are generally not trained in food processing.

Food laws and regulations of the country are not adhered to by many of the food processing operations. The Bangladesh Standard and Testing Institution (BSTI) has established standards for various fruit and vegetable products. These standards are adhered to by only a few of the large fruit processing factories. The current demand for processed fruits and vegetables is, however, increasing owing to improvement in local living standards and changes in food habits. Poor competitiveness of local products and the import of processed fruits and vegetable products has resulted in foreign products dominating the local market.

(iii) Currently, approximately 50 fruit processing entities exist in Bangladesh. These entities are engaged in the processing of mangoes, pineapples, papayas, bananas, tomatoes, chilis, eggplants, potatoes, carrots, garlic and radishes. The "Agricultural Marketing Co. Ltd. (AMCL) which markets its products under the brand name Pran" and the "Partex Group" which markets its products under the brand name "DANISH" are industrial fruit processing plants. AMCL-"Pran" is the leading and most successful agro-processing firm in Bangladesh.

Products of the AMCL include concentrates of mango and tomato, fruit juices, squash, jam, jelly, canned fruits and vegetables, pickles, fruit pulps, chips, chanachur, Toffee, 'Dal Fry', 'Chira Bhaja' and tomato ketchup. AMCL has captured a large market share in the processed fruit and vegetable sector. It produces quality products at competitive prices. Products of the AMCL are comparable to imports, but are more competitively priced than are imports. Processed AMCL products are growing in popularity in light of their comparably lower prices, good quality, attractive packaging and their safety.

Processed products produced to comparably higher quality standards, and with comparably better packaging than that produced for the local market are exported by AMCL to ethnic communities in Europe and North America. Prospects also exist for the export of such products to non-ethnic markets. Bangladeshi processed foods have the potential to penetrate markets in North-Eastern India, Nepal, Myanmar, Singapore and Asian Countries. Potatoes are currently exported to Singapore, Sri-Lanka and Malaysia and potential exists for the export of processed potatoes (hydrated or chilled) to other countries.

FOOD SAFETY REQUIREMENTS FOR ENTRY INTO FOREIGN MARKETS

Bangladesh is a significant agricultural producer and has set goals for increasing its export of fresh and processed foods to the EU and to the USA. The Middle East, Singapore and SE Asia also present market opportunities for Bangladesh. Market opportunities also exist in the north-eastern part of India, which has a population of 30 million people, as well as in Nepal and Bhutan. During the period 2001–2002, exports of horticultural produce from Bangladesh were valued at USD15 million.

Achieving adequate food safety control has become the essential ticket for entry into both the European food market and to the United States. The Middle East also has plans of increasing vigilance on food imports. This region has had food standards for a long time and codes are increasingly becoming more closely aligned, particularly under World Trade Organization negotiations and agreements.

European and US markets require that any food prepared and packed for shipment to their markets, whether processed or fresh, must be prepared under conditions which ensure that every reasonable precaution has been made to ensure that it is safe and wholesome and that it matches the description given. This should become the goal for Bangladesh.

GOVERNMENT POLICY

The Government of the People's Republic of Bangladesh has declared agriculture as a thrust sector in recognition of its multi-faceted contribution to the national economy. The government has taken the initiative to modernize the agricultural sector in light of WTO rules and SAPTA and other international treaties. The main elements of National Agriculture Policy include developing profitable and sustainable agricultural production systems, enhancing the purchasing power of farmers by increasing their real income, increasing the production and supply of agricultural produce suitable for the agro-processing sector, reducing imports of agricultural produce and products, increasing exports and facilitating the development of agro-processing industries.

The government has accorded priority to the expansion of agri-business. Cash incentives are being provided for the export of frozen foods, agro-based products, vegetables, fruits etc. in order to promote export oriented agro-based industries. The Government has provided a tax rebate for agro-processing industries, poultry farming, dairy, pisciculture, and horticulture in order to encourage investment in these sectors. The government has also declared the agro-based industry, frozen meat industry, jute industry, and the silk industries as thrust sectors and financial institutions have been instructed to reduce interest rates and provide additional long-term loans to these sub-sectors. The Honorable Prime Minister of the country has urged both domestic and foreign investors to increase their investment in these sectors, given the potential and demand for agri-products in Bangladesh. The Government is also ready and eager to provide all necessary assistance to expedite development of the fruit and vegetable processing sector.

CONSTRAINTS IN THE PROCESSING, PRESERVATION AND MARKETING OF FRUITS AND VEGETABLES

- Technical manpower, research and development activities are deficient and inadequate;
- Inadequacy of appropriate postharvest technologies for fruits and vegetables;
- Postharvest research and development activities are hindered owing to the lack of operational funds;
- Lack of training and demonstration activities and centers for fostering entrepreneurship;
- Lack of adequate credit facilities at reasonable interest rates, for growers;
- Poor price guarantees on the marketing of produce. Grower prices during the peak season of production are extremely low;
- Fluctuating nature of demand, high taxation, and absence of transport facilities create serious bottlenecks in the marketing of fruits and vegetables;

- Processing industries lack storage facilities for raw materials. Raw materials of a highly perishable nature therefore go to waste;
- Poor road and market infrastructure coupled with lack of technical know-how also result in high postharvest losses;
- Absence of quality consciousness among consumers, leads to preference for poor quality and unsafe produce which is generally less costly;
- Little sharing of information between farmers and processors on appropriate postharvest technologies;
- Operation of processing industries below their capacities;
- Failure to implement quality standards for a majority of food items, including fruits and vegetables;
- Poor linkages between Chambers of Commerce, industries and research institutions.

FUTURE STRATEGIES AND POLICY ISSUES

- Priority must be accorded to the postharvest sector so as to ensure food security, alleviate poverty, increase employment opportunities and promote national and foreign investment.
- A platform of networks should be created among growers, entrepreneurs, technology providers and consumers in order to provide the impetus required for accelerated investment in the sector.
- Postharvest research and development programs must be established at the national level in order to generate appropriate postharvest technologies, for pre-harvest treatment, harvesting at proper maturity stages, postharvest handling of fresh produce, the application of postharvest treatments, cost effective packaging, appropriate transportation, the production of value added products, and product formulation, dehydration and processing to assure quality and food security.
- Human resource development is required at all levels. Education and training of scientists, processors, extension agents, farmers, industrialists and marketing agents is also required. All human resource programs should consist of long- and short-term activities.
- On-farm sorting, pre-cooling, packing and storage facilities for fruits and vegetables are essentially required for distant/export marketing.
- Roads, storage facilities, cold storage structures and the legislation required to maintain these in good condition are required for proper functioning of postharvest infrastructure.
- Quality standards are to be maintained for food safety, security and international trade.
- Equipment manufacturers must be supported.
- Financial and technical support for the development of packaging industries is required.
- Fiscal policies which are conducive to development are required. Anomalies in duties and taxes should be removed.
- Sharing of information may be promoted through electronic media the dissemination of appropriate literature, and through the organization of training courses, meetings and conferences at the national and international level. Short video films, cartoon films emphasizing the nutritional, medicinal and therapeutic properties of processed fruits and vegetables would also be useful.

CONCLUSION

It is not possible to survive in this era of globalization by employing traditional farming techniques only. Geographically, Bangladesh is a small country with limited land resources. The availability of cultivable land is decreasing proportionately with increasing population. The country must therefore increase its productivity, diversify its agricultural production base and increase value addition through the processing of farm products.

Efforts must be made to strengthen the postharvest sector through intensive investment in research and development. The food industry must focus on the production of quality products for both the domestic and export markets. The economy of the country will be strengthened through quality improvement, increased production, increased market share and greater foreign exchange earnings derived form increased export of fresh and processed fruits and vegetables.

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2. CAMBODIA

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INTRODUCTION

Cambodia covers a geographic area of 181,035 km^2, of which 74% is forested, 17% is cultivated and 3% consists of pasture land. Cambodia has a total population of 13,099,472, of which more than 80% of Cambodia's population is rural or agrarian.

Cambodia has a tropical monsoon climate, with a defined dry and wet season. The dry season spans the period from November to April, while the wet season runs from May to October. Temperatures range from 21°C to 35°C.

CAMBODIA'S AGRICULTURAL SECTOR

Cambodia's economy remains largely dependent on agriculture. Agriculture accounted for about 38% of the GDP in 2001 and employed about 80% of the labor force in that year. Approximately 80% of the poor live in rural areas. Monthly rural household income has remained very low. Agricultural growth has on average lagged behind population growth since 1999, with large year-to-year fluctuations, reflecting insufficient investment in the sector, over-exploitation of natural resources, and poor weather conditions. Agricultural productivity is low, when compared with that of neighboring countries with comparable soil and weather conditions. The predominance of rain-fed agriculture subjects production to high weather vulnerability. Rain-fed rice is the main crop, covering about 90% of the cultivated land mass. Official exports are limited to rubber and fish but large quantities of paddy rice are illegally exported.

Agriculture-led strategies can, however, provide the key to achieving accelerated progress in the country. Growth in the agricultural sector can be fuelled by: increased production through higher productivity, containment of losses which could often be as high as 35–40%, sound postharvest support systems, crop diversification including horticulture and floriculture, and clearing of large areas of landmines and unexploded ordinances, and increased emphasis on animal husbandry and fisheries.

Growth in Cambodia's agricultural sector is constrained by:

- Small land holdings (0.75–1.0 hectare) and the lack of secured access and ownership of land which reduces farmers' incentive to invest
- Low productivity owing to inadequate access to fertilizers and seeds, underdeveloped irrigation facilities, and high transportation cost stemming from the poor condition of rural roads
- Lack of rural financial services which increases production and distribution costs
- Landmines and unexploded ordinances in large areas of the country which prevent effective land use

MANAGEMENT OF THE AGRICULTURAL SECTOR

Throughout the year, small farmers in Cambodia, cultivate several crops on their farmlands. Different crop varieties are grown in close proximity of each other with minimal spacing between crops. Cross-pollination may occur if different varieties flower at the same time, with significant impact on varieties. Relatively little care is taken to separate and characterize seeds prior to storage. Varieties cultivated over extended periods, therefore become impure, or completely lose their identity. Such is the case with traditional aromatic rice varieties which either partially or completely lose their aroma after several years of cultivation.

The principal Government organization involved in development of the agricultural sector is the Ministry of Agriculture Forestry and Fisheries (MAFF). Many civil servants are employed outside of their Governmental duties, in order to supplement their incomes.

Training of agronomists is not consistent with the real needs of the sector. Individuals trained in agriculture and with assigned responsibility for working in rural agriculture, also work in other areas. Many of these individuals are located in Phnom Penh.

The Department of Agronomy and Agriculture Land Improvement was established within the MAFF.

CROPS OF CAMBODIA

Rice is the main agricultural output and is the staple of the Cambodian diet (Table 1). It provides a major source of income and subsistence for Cambodian farmers. Approximately 2.3 million hectares of land are under cultivation with rice. Rice is cultivated primarily through traditional farming practices by over 80% of Cambodian farmers, 60% of whom produce it for their subsistence requirements. Rice production is predominantly rain-fed. Rice output accounted for about 46% of agricultural output in 2001 and to 17% of GDP. The present average productivity of 2.0 tons/ha is still lower than that of Vietnam and Thailand (3–4 tons/ha). Rice outputs could be increased through the use of high-yielding varieties of seed and fertilizer, development of irrigation facilities in some areas, and improvement in marketing arrangements.

Table 1. Some Subsidiary and Industrial Crops Produced in Cambodia during the Period 2000 to 2003

Years	2000		2001		2002		2003	
Crops	Area (ha)	Production (t)	Area (ha)	Production (t)	Area (ha)	Production (t)	Area (ha)	Production (t)
Rice	2,318,495	4,026,092	2,240,917	4,099,016	2,137,125	3,822,509	2,314,285	4,710,957
Cassava	16,279	147,763	14,239	142,262	19,563	122,014	25,740	330,649
S. Potato	7,435	28,178	7,225	26,252	8,136	31,530	8,716	34,897
Vegetable	32,755	195,894	35,311	184,640	34,433	143,175	36,090	139,626
Mung Bean	24,991	15,100	29,431	17,153	39,802	23,925	44,940	31,815
Ground Nut	10,370	7,490	11,913	8,913	13,840	9,738	14,563	18,483
Soybean	33,256	28,111	31,997	24,658	33,613	38,801	53,164	63,188
Sugar Cane	7,723	164,176	7,854	169,302	9,473	208,819	9,581	173,105

Source: Annual Conference on Agriculture Forestry and Fisheries, 2004

Other crops produced in Cambodia include maize, soybeans, fruits and vegetables. Domestic production of these crops is limited, despite Cambodia's potential for producing these crops. A major reason for these low levels of production is that vegetables are not traditional constituents of the national diet in Cambodia. A majority of the vegetables consumed in Cambodia are imported from Vietnam and Thailand. Efforts to increase vegetable production and consumption are underway, supported by UNICEF, with a view to raising the nutritional content of the national diet. Vegetable cultivation is labor intensive and generates higher levels of income than does rice cultivation. The low levels of vegetable and mung bean production could be attributed to the limited size of markets, and the lack of adequate postharvest infrastructure.

Cambodia also has untapped potential for fruit production. Much of the fruit consumed in the country is imported from Thailand and Vietnam.

Sugar cane is a good crop for rural societies in that it is not dependent on the public supply of power and creates local employment and skill besides generating valuable by products such as molasses, alcohol and bagasse (fiber) for paper manufacture. The scope for increasing production of this crop and the current constraints to its production require further study.

REDUCING POSTHARVEST LOSSES IN CAMBODIA

With grant support from the Mc. Knight Foundation through the International Institute for Rural Reconstruction (IIRR), the Centre d'Etude et de Developement Agricole Cambodien (CEDAC), has implemented a Project entitled "Increasing Income from Household Gardens by Reducing Postharvest Losses." The project is being implemented in 5 villages located in Saang and Kien Svay district, in Kandal Province. The objective of the project was to enable farmers to increase their incomes through improved postharvest management of targeted crops such as vegetables, fruits and flowers. Strategies and main activities to achieve this goal include the organization of training, provision of follow-up advice, organization and support of experiments at the farmer level, organization and facilitation of exchange among farmers, provision of informative materials and recording and capitalizing on indigenous knowledge and practices in improving postharvest handling.

Summary of Activities and Results of the Project

Participatory Rural Appraisal

Needs assessments for the improvement of postharvest management systems commenced in November 2001, in 5 target villages in Saang and Kien Svay district, in Kandal province. The target villages were O Rumchek, Knong Prek and Svay Tani in Saang district and Koh Krabei and Roboh Angkagn in Kien Svay district. Ten to fifteen farmers from each village were invited to participate in the collection of information. Invitations were issued either by letter and/or verbally through the chief of the village.

Information pertinent to the area of land cultivated by the family, levels of losses at various steps of the postharvest handling chain, time of harvest, and income and expenditure of production was collected.

Baseline Survey

A baseline survey involving 137 families was conducted during the period January 7 to 17 2002. The information collected from 130 of these families was validated.

Data were collected as follows:

Farmers were invited to participate, either through letters of invitation, or through the verbal invitation of their village chief. Farmers who grow and sell their produce were selected for interview. Information was collected at nighttime, owing to the fact that farmers were occupied during the daytime.

Data were collected at the household level on; the area of land cultivated; important crops in the village; tools used at every step during postharvest handling; method of harvesting; level of losses and the labor used in postharvest handling activities.

This information was valuable for the baseline record of the project. It was used as a basis for analyzing the practices of farmers in these targets areas.

Case Study on Indigenous Practices

A case study was conducted on each category of crop, including vegetables, fruits and flowers. Information was collected on: best postharvest handling practices, including harvesting, cleaning, trimming, storage and transportation; tools, time and duration of each activity and gender participation in these activities. Case studies were conducted in the field during farmer practices and photographs were taken.

Farmer practices were studied through individual and group meetings. Twenty-five crops were selected for the case studies. Informative leaflets were prepared on 20 of these crops. Leaflets were prepared on 12 varieties of vegetables; 3 varieties of flowers; and 5 varieties of fruit. These leaflets were prepared as guidelines to reinforce training or to be copied by farmers. Notes recorded from the farmer's experiments were also used as reference materials for the training.

Training on Postharvest Handling

Participants were selected for training on the basis of the results of the baseline survey, and through consultation with village chiefs. A small group discussion was conducted in each village, and 6 farmer leaders were selected.

A training course on "Postharvest Handling" facilitated by IIRR and CEDAC was held during the period 21–22 January 2002. Twenty-five participants representing 13 organizations and institutes, and 6 farmers from 5 selected villages participated. The farmers selected were either representatives of farmers or leader of the villages.

Training included technical presentations, group discussions and practical exercises on the handling and storage of several varieties of vegetables:

Specific activities included:

- Brainstorming on postharvest handling treatments (including trimming, cleaning, storage and transportation);
- Provision of basic information on postharvest practices;
- Sharing of experiences among farmers and trainers;
- Provision of training materials to farmers.

At the end of the process farmers were requested to volunteer to conduct trials on the crops that they grow. A total of 47 farmers participated in the training.

Postharvest Experimentation

In order to reinforce training, postharvest handling practices in Jasmine were discussed with farmers. Experiments were conducted by four farmers. Materials were also provided by the project, for the conduct of experiments. These included storage containers, plastic boxes, and plastic bags among others.

Exchange Visits within Cambodia

Exchange visits among villages Several inter village exchange visits were organized for selected farmers in each village, in order to allow them to observe results obtained by farmers in other villages. These exchanges were designed with the objective of changing practices and experiences of farmers who participated in the project. Relationships and communication among farmers in the project area improved as a result. There was greater sharing of experimental results, and ideas were developed for new experiments. Experimental results were documented for the preparation of extension leaflets. During the experimental period, farmers shared the responsibility of identifying the problems faced and funded the support of new trials, and the dissemination of documents to other farmers in the villages.

Exchange visit to the market It was found that farmers in the target area showed very little concern for the postharvest handling and marketing of their produce. Farmers never discussed increasing the price of their produce through innovative handling practices, with middlemen. However, the project provided the opportunity for farmers to see the market, observe produce from other countries such as Vietnam and Thailand, and discuss the produce with middlemen. During discussions with middlemen, they found that crops from Vietnam and Thailand were better priced than Cambodian produce, owing to better postharvest handling practices in Vietnam and Thailand. This finding provided Cambodian farmers an incentive to improve their practices and to raise the awareness of farmers in the target area. Further to these visits, farmers shared ideas learnt at the market, with others in their villages. In addition, they met new middlemen clients at the market.

Project Results

To date, 305 farmers have benefited from the project:

- 159 families were exposed to training on Postharvest Handling.
- 251 families were exposed to group training (group dynamic).
- 25 families conducted experiments on vegetables, fruits and flowers.
- 20 crops were studied and leaflets were prepared for wider dissemination in Cambodia.

It is estimated that around 44 families have completely adopted the improved postharvest practices introduced by the project, 212 families have adopted some of the improved postharvest practices, while 49 families showed a low level of adoption.

It can be concluded that through the project, improvement of postharvest management has begun in Cambodia.

CONCLUSIONS

Agriculture is an important sector of Cambodian economy. Rice is the staple crop. Agricultural productivity is low. Cambodia has enormous potential for growing horticultural crops such as fruits and vegetables. However, such potential has not been taped as yet owing to the challenges in human capacity, financial resources, poor legal frameworks and the lack of support governmental support. Most of the fruit and vegetables are imported from the neighboring countries such as Thailand and Vietnam.

The development of postharvest management of fruit and vegetables is in infancy. Since majority of the farms and agri-enterprises are small-sized, agro-industrial development in Cambodia is very closely linked to small and medium enterprise promotion policy. Government assistance is required in areas of: agro-enterprise credit support, export facilitation, product standardization and quality control, research and development services and market access. Developing local industries, particularly in agro-industry and in food processing, will help to reduce the country's dependence on the import of consumer products. To achieve greater domestic production, significant reduction of smuggled products would improve the competitiveness of local produce and products. Concerted efforts of all stakeholders are needed for enhancing agricultural productivity and for reducing postharvest losses.

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3. REPUBLIC OF CHINA

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INTRODUCTION

The development of modern marketing systems began 20 years ago with the establishment of supermarkets alongside traditional marketing systems. The cold chain was developed in order to ensure the availability of properly packaged units of vegetables. Today, chilled vegetables are also supplied in large quantities to hypermarkets and to institutions such as schools, companies, institutes, and military units. More than 30% of vegetables produced in the Republic of China are distributed through cold chain systems. Postharvest losses are tremendously reduced and the quality of vegetables is higher than that of vegetables marketed through traditional marketing systems.

Vegetables are produced on a year-round basis in the Republic of China. High temperatures and continuous rain during the spring and summer months, however, destabilize vegetable supplies. Shortages of vegetables always result in a dramatic increase in price, particularly in the case of leafy vegetables. Wholesalers, therefore, store vegetables in order to maintain their vegetable supplies.

Consistency of supply is most important in modern marketing systems since vegetables are generally supplied to consuming firms on contract and must be delivered at a fixed price. Many leafy vegetables have a short shelf ife, and can be stored for only 1 to 2 weeks under refrigerated conditions. Losses may exceed 40% after 2 to 3 weeks of storage. Controlled atmosphere storage (CA storage) which was recently introduced in the Republic of China, has been proven to prolong the storage life of these leafy vegetables. Storage losses are reduced to 15% or less in commercial CA storage systems.

REDUCING POSTHARVEST LOSSES THROUGH THE COLD CHAIN

Marketing Channels for Vegetables in the Republic of China

Approximately 3,200 metric tons of vegetables are produced in the Republic of China on an annual basis. Approximately 70% of these vegetables are distributed through the traditional marketing system. Through this system, produce is mainly transferred to shipping point markets in the vicinity of the producing area, or to terminal wholesale markets in the vicinity of the consuming city (Figure 1). The vegetables are subsequently transported to retailers for sale.

The remaining 30% of vegetables are delivered to consumers through the modern marketing system. Within this system, produce is marketed primarily through cooperatives or farmers associations. The vegetables are pre-cooled and packed into consumer packaging, following which they are transported to the various institutions. This system therefore allows the distribution of vegetables to consumers through a direct route.

Reducing Postharvest Losses in Traditional Marketing Systems

Vegetables are transported and sold at ambient temperature in the traditional marketing system. Rapid transportation and few distribution steps are essential if postharvest losses are to be reduced. Vegetables can normally be delivered to consumers within 24 hours after harvest in most areas of the Republic of China. In a new type of marketing system, referred to as the afternoon market, vegetables are delivered to consumers within a 12-hour time frame. Vegetables harvested during the early morning are collected by retailers in shipping point markets or from growers at noon, following which they are sold in the city during the afternoon of the same day. Freshness and low price attract consumers.

Relatively little is done to reduce postharvest losses in produce destined for the traditional marketing system. Significant quality deterioration occurs in highly perishable vegetables. Ice packaging and hydro-cooling are commonly applied to enhance freshness.

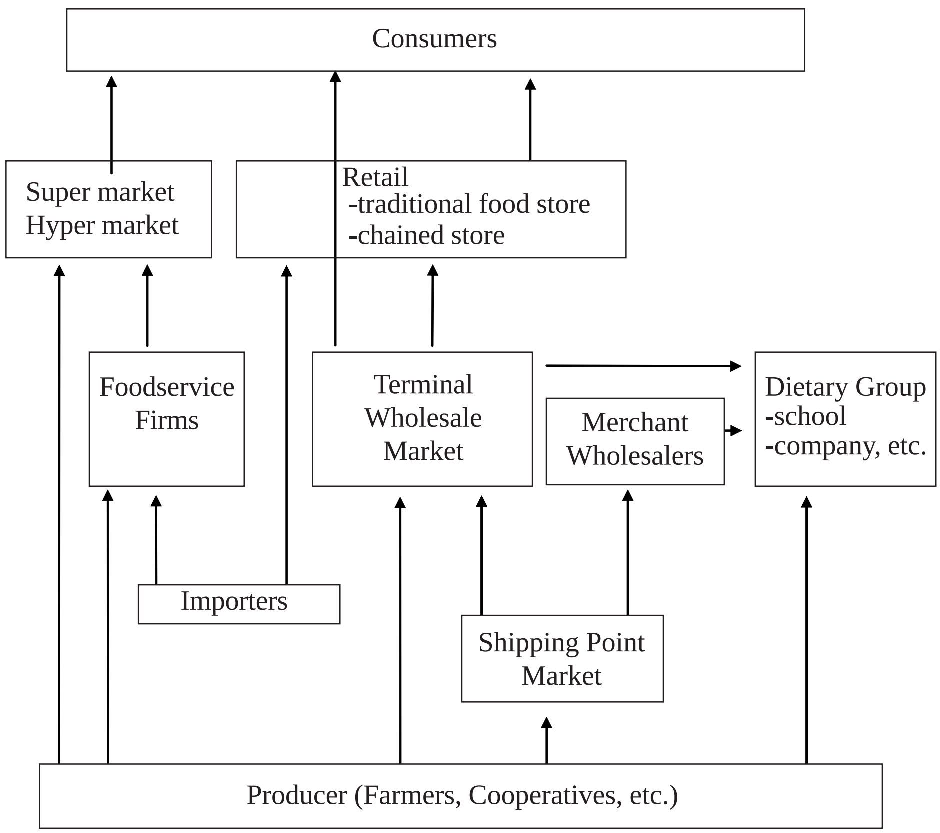

Figure 1. Major Marketing Channels for Agricultural Produce in the Republic of China (Adapted from Y E Chan 2003)

Ice Packaging

Ice packaging is used for cooling vegetables during their distribution through the traditional marketing system. The temperature within a box of leafy vegetables may increase to between 35°C and 40°C when the box is sealed in the afternoon and auctioned the following morning. Ice packaging can, however, lower the temperature to between 20°C and 25°C. Ice packaging is also effective in reducing leaf yellowing, wilting and trim loss. It is commonly used to reduce fiberization in the leaf stalk of celery and in bamboo shoots as well as to prevent softening of long yard beans. In most cases, ice packaging is applied by layering ice over vegetables such as celery and bamboo shoots. In the case of vegetables such as edible amaranth and long yard bean, which are susceptible to chilling injury, a layer of newspaper is placed between the layers of vegetables and ice. The thickness of the alternating layers of vegetables and ice is dependent on the type of vegetable, the ambient temperature and the distance or the time to the market. During transportation and auctioning at the market, the ice melts.

Root vegetables must be properly cleaned prior to packaging, so as to avoid soil-water mixtures from forming upon melting. Water resistant paper liners are generally included within packages in order to prevent weight loss and to maintain low temperatures. Either polyethylene liners or large polyethylene bags are used for the ice-packaging of bamboo shoots and for the packing of some water tolerant leafy vegetables, in carton boxes. This method is useful for transportation over short distances. Bagged ice or ice-filled plastic bottles can also be used for the low temperature storage, of vegetables in carton boxes, destined for shipment by air freight. Wrapping a layer of newspaper around the container of ice is useful in shielding vegetables from direct contact with the ice.

Hydro-cooling

Hydro-cooling by dipping in cold water, is extensively used for long yard beans, and bamboo shoots. The water may be cooled either through the addition of ice, or by refrigeration as is used in the case of bamboo shoots. Leafy vegetables and long yard beans are repeatedly sprayed with water in shipping point markets, in order to maintain low temperatures and to prevent wilting or softening, particularly during the summer months.

Reducing Postharvest Losses in Modern Marketing Systems

In the modern marketing system, cleaning, sorting, repacking and pre-cooling treatments, generally take one day. Maintaining low temperatures throughout this process is essential to reducing postharvest losses. Vegetables are cooled upon arrival at packing stations. The packed produce is maintained at low temperatures during transportation, short term storage and retailing. The entire sequence is referred to as a cold chain since all steps of the distribution system are maintained at low temperature.

It is estimated that trim loss in cabbage can be reduced from 30% to 10% by pre-cooling. Furthermore, many vegetables can be stored for one week in the cold chain system, while they must be discarded after one day in the traditional marketing system.

Cold chain systems were developed to meet the requirements of supermarkets. The cost of maintaining a cold chain system is, however, very high, given the high cost of the equipment and its operation. Many pre-cooling techniques have been well adapted in the Republic of China.

Hydro-cooling

Hydro-cooling is commonly applied for the rapid removal of field heat from fruity vegetables and many kinds of leafy vegetables. Hydro-cooling increases the freshness of leafy vegetables. Hydro-cooled vegetables must, however, be kept cool in order to prolong their shelf life.

Room-cooling

Room cooling is a simple pre-cooling technique. Vegetables are simply retained in a refrigerated room prior and subsequent to packaging. Room cooling takes longer than other cooling methods. It is used for cooling vegetables such as cabbage and head lettuce, that cannot be cooled by either hydro cooling or forced air cooling. Room cooling can also be applied in the cooling of fruity vegetables, and is widely used for the cooling of vegetables packed in consumer packages.

Forced Air Cooling

Forced air cooling is widely applied in cooling vegetables destined for delivery to institutions such as supermarkets, for storage and for long term transportation such as over-sea transportation. It cools the produce at a more rapid rate than does room cooling, and thus increases efficiency in the cold chain. Forced air cooling is, therefore, important in modern marketing systems. The facilities and techniques for forced air cooling have been developed and adapted for use by small companies or cooperatives in the Republic of China. Tunnel stacking, forced air cooling systems are the most popularly used pre-cooling systems in the Republic of China. High refrigeration capacity and high relative humidity are extremely important in forced air cooling systems. Cooling efficiency is affected by the method of packing and the quantities and types of vegetables to be cooled. Labor is required for stacking and operation. In some cases, forced air cooling is substituted with vacuum cooling owing to the higher efficiency and lower labor requirements of the latter. Forced air cooling facilities are, however, much less costly than are vacuum cooling facilities.

Vacuum Cooling

Vacuum cooling has been commercially used, ever since the Republic of China began manufacturing vacuum systems three years ago. Almost all kinds of leafy vegetables can be thoroughly cooled by vacuum cooling, within a short period of time. Vacuum cooling is extremely useful for head vegetables such as cabbage, head lettuce etc. High cost limits the use of vacuum cooling. Currently, only a few cooperatives use vacuum cooling.

REDUCING POSTHARVEST LOSSES THROUGH CONTROLLED ATMOSPHERE STORAGE

Vegetable Storage in the Republic of China

Vegetables such as carrots, potatoes, garlic bulbs, and cabbages for processing, are usually harvested in March or April and are stored till October, for sale during the off season. Pears and apples from mountain areas, which are harvested in October, are stored till March of the following year.

Vegetable storage is common in modern marketing systems. Vegetable supplies for supermarkets or for other institutions must be stable in quantity and quality, and prices are fixed through contractual arrangements. However the supply and price of vegetables varies considerably in shipping point markets or at the grower level depending on weather conditions. Short term storage of vegetables is necessary and long term regular storage is also required.

Overproduced vegetables are generally stored. Cabbages, Chinese cabbage, and cauliflower, for example, are always overproduced during winter months, while garlic bulbs may be overproduced during spring. The duration of storage these overproduced vegetables varies in accordance with demand and supply in the market place.

Vegetable imports such as broccoli, asparagus, pea pods, head lettuce and celery, can be stored over short periods thereby prolonging and stabilizing their supply on local markets.

The Development of CA Storage

Vegetables are commonly stored during spring and summer in order to stabilize supplies in modern marketing systems. The storage life of most leafy vegetables grown during spring and summer months varies between 7 and 14 days. Vegetables are generally in short supply for a 14 to 21-day period or even longer, during the typhoon season. Storage losses are high, and the quality of vegetables after trimming and cold storage is always poor. Improved storage methods are therefore required.

Controlled atmosphere (CA) storage was proven effective in prolonging the storage life of cabbages on a trial basis. Earthquakes may, however, destroy the air tightness of storage construction, and limit the development of commercial CA storage systems. Recently, a breakthrough was made in solving this problem. An air tight construction of steel frames and iron sheets was set up as a CA room within a cold room. The air tightness of this construction was not affected by earthquake activity. The CA room had a capacity of between 18 and 20 tons of leafy vegetables. Oxygen and carbon dioxide levels within the CA room were monitored on a daily basis throughout the storage period, with the use of an atmosphere auto control unit (ACU, Nitec USA). This unit also has the capacity to control the oxygen and carbon dioxide concentrations when equipped with a nitrogen generator, an air compressor and a carbon dioxide cylinder.

To date, the system has been used a total of 5 times. On each occasion, a total of 17 to 20 tons, consisting of 10 varieties of leafy vegetables were stored under CA conditions: oxygen concentrations were controlled at 2 to 3% and carbon dioxide concentrations were controlled at 5 to 6%. The temperature was controlled at 2 to 3°C or 3 to 4°C depending on the need. The temperature within the CA room fluctuated by about 0.8°C while it remained at approximately 4°C in the storage room. Ethylene concentrations were maintained at levels lower than 0.2 ppm through the use of 4 small ethylene absorbers filled with potassium permanganate within the CA room.

Results showed that the quality of vegetables in CA storage was maintained after 18 to 24 days of storage. Some of vegetables stored under these conditions were observed to be as fresh as just after harvest. The quality of vegetables maintained in refrigerated storage deteriorated, and some underwent partial decay. The storage loss was about 54% in refrigerated storage while it was about 14% in CA storage.

CONCLUSION

The cold chain system is effective in reducing postharvest losses in vegetables. It is costly and must be adapted to modern marketing systems which are reliant on socio-economic conditions. Without modern marketing systems, cold chains would be highly underutilized. On the other hand without cold chains, modern marketing systems would not be possible. Approximately 70% of vegetables are still distributed through the traditional marketing system. Retail at ambient temperature constrains the use of cold chain. Pre-cooled vegetables especially leafy vegetables may decay more rapidly, if they are not kept cool during transportation and retail.

Controlled atmosphere storage has been proven effective in reducing storage losses and in prolonging storage life during the short term storage of leafy vegetables. The difficulty in setting up an air tight CA room has posed a major constraint to the development of the technology in the past. With the breakthrough of establishing a CA room within a cold room, CA storage can be applied in increasing the long term storage of vegetables. Potential opportunities for application of CA storage, however, need further investigation.

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4. FIJI

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INTRODUCTION

Fiji's agricultural sector accounts for 19% of its GDP. Agriculture plays a pivotal role in the economy and provides a major source of employment. In 2003, the Government accorded priority to the production of horticultural crops through the establishment of an agricultural development program. To this end, the Ministry of Agriculture, Sugar and Land Resettlement (MASLR) has focused on investing in areas which offer potential for the agricultural sector and that would contribute to the national economy, with the aim of strengthening current enterprise development by 2005. Prioritized horticultural commodities include ginger, dalo (also referred to astaro), kava, tropical fruits (papaya, mango, pineapple and breadfruit) and vegetables (eggplant, okra and chilli).

Experience in Fiji had shown that high-value export markets cannot be developed and sustained through informal arrangements among small exporters. Large-scale commercial plantations can offer a solution, and should be developed with the appropriate resources and infrastructure.

Consumers in domestic and overseas markets increasingly demand agricultural produce of high quality for which they are prepared to pay premium prices. Meeting these quality requirements will necessitate upgrading current practices within the agricultural sector. Small farmers, under the direction of commercial exporters and processors should play a key role in the process.

The Extension Service of the Ministry of Agriculture Sugar and Land Resettlement was established with the objective of promoting the use of improved methods of production and postharvest handling. Assistance was, however, needed to develop postharvest capacity that would enable it to work jointly with the quarantine service and assist farmers and exporters in meeting quality standards while minimizing postharvest losses.

Relatively little research has been geared toward the reduction of post- harvest losses in fruits and vegetables, owing primarily to the lack of funding, technical expertise and appropriate technologies. Postharvest losses have been attributed to inappropriate harvesting methods, fruit physiology after harvest, handling, packaging, storage and transportation.

BACKGROUND

Fiji covers about 1.3 million km^2 of the South Pacific Ocean, with a total land area of 18,333 km^2. The two major islands Viti Levu and Vanua Levu have areas of 10,429 km^2 and 5,556 km^2, respectively.

Eighty three percent of the land in Fiji is owned by indigenous Fijians, while nine percent is state owned and eight percent is freehold land. Only 16% of Fiji's landmass is suitable for agricultural production. Most of this productive land is situated along the coastal plains, river deltas, and valleys.

Currently Fiji has a population of 850,000.

Fiji enjoys a tropical South Sea maritime climate with neither extremes of heat nor cold. The islands lie in an area which is occasionally traversed by tropical cyclones, during the period November to April.

Temperatures average around 22°C (72°F) during the cooler months (May to October) while during November to April, temperatures are relatively higher with heavy downpours. Although rainfall is highly variable, the average rainfall increases steadily inland from coastal areas.

OVERVIEW OF THE FRUIT AND VEGETABLE SECTOR

Fruit Sector

Climatic and agronomic conditions in Fiji are suited to the production of a diversity of tropical fruits. Recent studies indicate considerable potential for future export growth in Fiji's fresh fruit sector. Mangoes, pawpaws and pineapples (and indigenous fruits such as breadfruit) for which export opportunities exist in New Zealand, Australia, Canada and Japan, offer the greatest export potential.

Indigenous fruit are produced on a seasonal basis, with periods of glut production. Much of the fruit is sold on the local market. Considerable postharvest losses are sustained during periods of glut production.

Vegetable Sector

The Fijian vegetable sector has good potential for commercial development based upon attractive export markets for fresh vegetables in New Zealand, Canada and Australia. Fiji benefits from marketing windows of opportunity in these countries. New Zealand is the major export market for fresh vegetables from Fiji.

A large number of small producers employ traditional technologies in vegetable production, in Fiji. Vegetables are produced primarily in the Sigatoka valley, where climatic conditions are most suitable. Hydroponic units designed to produce a variety of temperate vegetables for local supermarkets and the hotel industry, have been established in the dry zone of Viti Levu.

Given the small size of the local market for fresh vegetables and the fact that it is adequately supplied, efforts should be made by commercial producers to satisfy the increasing demand of export markets. To this end, the focus must be on the year-round production of high quality vegetables. In line with this, the Government has embarked on a program to improve and promote the production of selected vegetables for the off-season period. This work is funded through a Chinese Technical Assistance Mission and involves vegetable production on demonstration plots, as well as hydroponic farming.

Vegetables are generally planted in the cooler months or main season, which runs from May to October. Off-season vegetable production takes place between November and April.

Considerable potential exists for growth in the export of fresh and processed vegetables. Fijian vegetable exports account for net foreign exchange earnings of USD0.5 million dollars on an annual basis.

FACTORS WHICH CONTRIBUTE TO POSTHARVEST LOSSES

Fresh fruits and vegetables are produced for both domestic and export markets. Fruits and vegetables geared for the export market are administerd to, by the Quarantine Department. Given the stringent standards of export markets, exporters must endeavor to meet standards for quality and freshness in order to ensure the competitiveness of their produce.

Losses incurred in vegetables produced for export markets are primarily due to inherent difficulty in consolidating small quantities of produce from numerous small farms, to satisfy volume demand. Where large shipments can be consolidated, considerable variation in quality occurs.

Postharvest losses in produce destined for the domestic market are comparably greater than in produce destined for export markets. This marked difference is primarily due to postharvest practices implemented by the farmer, and the leniency of the domestic market. Losses incurred on the local market are the result of physical damage during handling and transport, physiological decay, water loss, or sometimes simply due to market surplus.

Factors which contribute to fruit and vegetable deterioration in Fiji include: insect attack, particularly fruit fly damage; poor field sanitation; unstructured grading and packaging systems; limited farmer knowledge of postharvest handling and fruit and vegetable processing technologies and the high day-time temperatures.

POSTHARVEST HANDLING OF HORTICULTURAL PRODUCE

Postharvest Technology

An FAO funded project conducted in the year 2000 provided assistance in postharvest handling. This project focused on the training of a diversity of stakeholders, including producers, middlemen, exporters and buyers such as hotels, in postharvest handling practices. Through this project, community based pack houses were introduced to assist growers, in sorting produce at the farm level, prior to distributing it to various markets. The Government is in full support of establishing rural market centers with the financial backing of FAO funding. A community pack house was established in Sigatoka which is the main fruit and vegetable growing area, and which is commonly known as the ‘salad bowl’ of Fiji.

Blast freezers, coolers, vacuum packing, sorting bins, and packaging tailored to cushioning fruits and vegetables during transportation have been set up by commercial exporters of fresh produce.

A few companies supply institutions such as supermarkets, schools, hospitals, universities, prisons, the army and other colleges that have boarding institutions, with their fresh produce requirements, on contract. These wholesale companies are generally equipped with proper cool storage facilities for the storage and transportation of their fresh produce.

Postharvest Processing of Fresh Produce

There is a marked difference between the methods applied in processing of fresh produce destined for the export market and that destined for domestic markets. Fruit destined for the hotel industry, are similar in quality to those destined for export markets. Commodities destined for export markets are sorted and graded on the basis of, size, shape, variety, and color. Sorting and grading are performed on sorting tables and benches. The skin and the leaves of the fruits are wiped and cleaned to ensure the absence of blemishes and/or sap residues, prior to packing into boxes or clear plastic. The produce is stored in cool storage until ready for shipment.

Value-added Horticultural Produce

Three companies are involved in the processing of fruits and vegetables. Value-added products include canned, pickled and dried fruits and vegetables. Chutneys are also popularly produced.

POSTHARVEST LOSSES IN FRUITS AND VEGETABLES DESTINED FOR THE NEW ZEALAND MARKET

Data collected by the High Temperature Forced Air (HTFA) treatment facility, provides a good perspective of the rate of postharvest losses in fruits and vegetables which serve as fruit fly hosts. Losses are determined by calculating the difference between total production transferred from the field to the treatment centre and the total production exported. This data reflects the the quantity recorded for treatment, quantity exported and the quantity rejected per commodity for produce shipped to New Zealand between 2000 and 2003 (Table 1).

Table 1. Total Commodity Received at the Height Temperature Forced Air Facility (2000–2003)

Commodity	Quantity Recorded for Treatment (kg) A	Quantity Exportable (kg) B	Quantity Rejected (kg) A - B	Rejects as % of Quantity Exported
YEAR 2000				
Eggplant	214,441	196,735	17,706	9%
Pawpaw	69,916	66,906	3,010	4.5%
Mango	30,140	26,672	3,468	13%
Breadfruit	-	-	-	-
YEAR 2001				
Eggplant	269,764	245,708	24,056	10%
Pawpaw	168,480	161,403	7,077	4%
Mango	74,076	66,419	7,657	12%
Breadfruit	2,218	2,063	155	8%
YEAR 2002				
Eggplant	272,357	249,871	27,486	11%
Pawpaw	182,042	173,373	8,669	5%
Mango	272,357	249,871	27,486	11%
Breadfruit	5,945	5,454	491	9%
YEAR 2003				
Eggplant	297,739	270,672	27,067	10%
Pawpaw	142,680	137,192	5,488	4%
Mango	51,728	16,602	5,126	11%
Breadfruit	7,369	6,823	546	8%

(Figures extracted from HTFA TREATMENT FACILITY)

DEVELOPMENTS IN THE MANAGEMENT OF POSTHARVEST LOSSES OF FRUITS AND VEGETABLES

In recent times, quality standards have been developed for fruits and vegetables destined for export and local markets. Strategies to minimize postharvest losses by exporters and farmers include the following:

- Upgrading of roads in order to minimize transportation losses and facilitate timely delivery of fruits and vegetables to their desired destinations;
- The Ministry of Agriculture recommends that all fruit and vegetable exporters own cooling facilities, and store fresh produce in these facilities immediately after grading;
- Rural electrification is available to enable the operation of on-farm cool storage;
- Produce is packed in crates and field bins;
- Farmers are advised to store harvested produce under shade immediately after harvesting;
- Water sprinklers are set up on farms (by Taiwan ROC) to improve field management practices for vegetables;
- Farmer and exporter training, awareness, workshops designed to provide education on the management of postharvest losses have been conducted by the Ministry of Agriculture's Extension and Quarantine Division and by the Secretariat of the Pacific Community;
- Farmer cooperative groups have been formed in Sigatoka Valley to sell quality produce to hotels through organized phased planting of vegetables. These groups have established agreements with hoteliers to supply quantities requested at agreed prices;
- The technologies in developed countries cannot be adopted, owing to the lack of technical know-how and financial constraints faced by the local farmers.

QUARANTINE SERVICES

The primary role of the Quarantine Division is to reduce postharvest losses in an effort to ensure that all practices from production to export are strictly adhered to. Any farmer or exporter found violating the system is automatically suspended for non compliance. Farms are therefore closely monitored by the Quarantine and the Extension Departments.

SALIENT APPROACHES AND TECHNOLOGIES USED TO REDUCE POSTHARVEST LOSSES IN FRUITS AND VEGETABLES

An approved commodity pathway and unit inspection sampling procedures reduce postharvest losses in Fiji. The application of integrated pest risk management to produce destined for the New Zealand market, has not reduced the occurrence of pests and diseases, but has resulted in continued growth of that market since 1996.

In order to assure compliance with export requirements, all inspections are recorded, and each grower is allocated a grower registration number. This facilitates trace back audits for the identification of critical non-compliance and the implementation of correctives action.

NATIONAL APPROACH TO REDUCING POSTHARVEST LOSS

A major issue at the national level is that of ensuring strict compliance with quality standards agreed to under International Agreements and Statutory regulations. It will therefore be necessary for the Fijian Government to strengthen and accelerate the participation of all farmers in sustainable farming systems.

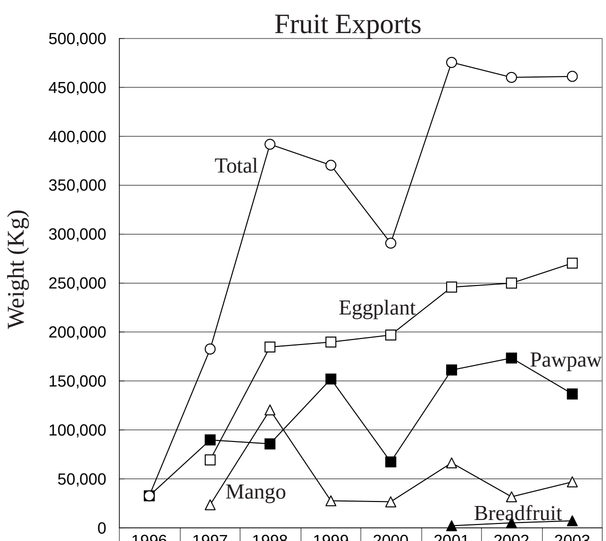
Another national issue in Fiji is that of facilitating the marketing of quality agricultural produce and value added products. In this regard, farming must be promoted as a rewarding form of employment in order to upgrade the standards employed by farmers.

Efforts will be made to train young farmers and provide agricultural education at all levels, including in the farming communities. Farmers should, in the process, also be provided with awareness raising materials.

Through the assistance of Governments, roads are being upgraded; utilities such as electricity, water, and communication networks are being provided along with improved shipping/airline services. These strategies are in place to reduce postharvest losses from 20% to 10%. This proactive approach of the Government has been very encouraging to farmers and stakeholders.

A CASE STUDY OF THE QUARANTINE PATHWAY FOR THE EXPORT OF VEGETABLES (EGGPLANTS) TO THE NEW ZEALAND MARKET

1. Many of Fiji's horticultural export markets were lost with the banning of the chemical, ethylene-dibromide (EDB), as a quarantine treatment in 1990. Fiji was, however, proactive in addressing this constraint. With the assistance of USAID's Commercial Agricultural Development (CAD) Project, Fiji embarked on an ambitious project to acquire HTFA quarantine treatment technology developed by the United States Department of Agriculture (USDA) for the treatment of Hawaiian papaya exports to the US mainland.
2. USAID required that the quarantine treatment facility be operated by the private sector (the industry). This was a major departure from the traditional operation of quarantine facilities by governments. The Ministry of Agriculture had the foresight to embrace this new approach, which led to the transfer of HTFA quarantine treatment technology to Fiji and the creation of businesses to operate the treatment facility. The Natures Way Cooperative (NWC) was formed to operate the facility on behalf of industry (exporters and growers of fruit fly host products). Today, as a result, Fiji has a thriving and growing industry in the export of fruit fly host commodities to New Zealand (Figure 1).



	1996	1997	1998	1999	2000	2001	2002	2003
PAWPAW	33,037	90,010	85,965	152,000	66,906	161,403	173,373	137,192
EGGPLANT		69,615	185,155	190,000	196,735	245,708	249,871	270,672
MANGO		23,072	120,209	28,000	26,672	66,419	31,129	46,602
BREADFRUIT						2,063	5,454	6,823
TOTAL (kg)	33,037	182,697	391,329	370,000	290,313	475,593	459,827	461,289

Figure 1. Export of High Temperature Forced Air (HTFA) Treated Products (1996–2003)

THE FIJI QUARANTINE PATHWAY

Bilateral Quarantine Agreement (BQA)

Following establishment of the High Temperature Forced Air (HTFA) treatment, a Bilateral Quarantine Agreement (BQA) was signed by NZMAF. This agreement necessitates that Fiji facilitate technical requirements of pest risk management in accordance with requirements of the importing country. As a follow up to the establishment of this BQA, an export pathway for fruits and vegetable destined for export to New Zealand was developed.

Grower and Site Registration Growers who produce eggplants for export to New Zealand are required to sign a declaration. These growers and their production sites are subsequently registered by the Fijian Ministry of Agriculture, who provides them with a grower number. Grower and exporter records are subsequently retained by with the Extension and Quarantine Division of the Ministry of Agriculture.

Field Control Measures

Field Hygiene Growers ensure that eggplants and other fruit fly hosts, crops that are ripe, overripe (not needed for use), and that have fallen in the field, or discarded during harvesting, are removed from the registered site and surrounding area and disposed off in the proper manner.

Harvest Growers only harvest eggplants for export to New Zealand from the registered sites. Only sound eggplants are harvested using proper techniques. Harvested eggplants are taken to the exporter’s pack house for grading in well-secured grower numbered bins.

Exporter/Pack house All export pack houses are registered and licensed by Fiji’s Agriculture Quarantine Division.

Grading and Selection Pack houses maintain daily records of growers who supply eggplants for packing. All eggplants (100%) supplied by growers for export to New Zealand are inspected for the presence of fruit fly eggs, larvae and pupa and for symptoms of their presence. Eggplants which are bruised or which contain soft-spots, skin punctures, stings, infestation from other quarantine pests, and decay are rejected for export to New Zealand. All records are maintained by the exporter and made available for inspection to the Fiji Agriculture Quarantine Division.

Inspection Procedures Staff of the Quarantine section of the Ministry of Agriculture undertake thorough inspection of eggplants supplied on a grower basis after the pack house staff have completed their inspection and grading. Eggplants with bruises, soft spots, skin punctures, stings, infections and infestation by pests, signs of decay and suspect fruits are rejected. The exporter ensures that the eggplants are transferred promptly to the High Temperature Forced Air Chamber with a complete transfer slip/form. Fruit fly surveillance and monitoring is carried out in the production area.

Treatment Facility/Quarantine Inspection & Post Treatment Security Eggplants graded by HTFA staff are further inspected by Agriculture Quarantine staff, following which they are treated in the chamber in accordance with the Quarantine Procedures Manual for the operation of the chamber.

Phytosanitary Certificate On completion of the treatment a further inspection is carried out prior to the issuance of an International Phytosanitary Certificate.

CONCLUSIONS

Considerable research and training will be required to reduce the high levels of postharvest losses in fruits and vegetables in Fiji. Fijian farmers still require training in postharvest techniques in order to ensure the maintenance of freshness in produce when it reaches the consumer.

Technical and economic constraints both account for the high levels of losses sustained in the region. The use of simple, low-cost methods should be encouraged for small holders who produce for the local market.

Dehydration technologies, which require inexpensive equipment, should be developed for cottage and small industries, while tropical fruit purees should be exported for reprocessing with temperate fruit. Simple processed horticultural products should be introduced by extension staff, to village communities in order to reduce postharvest losses and to maximize the use of rejected produce.

Available horticultural produce should be studied within the context of its processing and market potential. Collaboration is recommended among researchers working in horticultural production in order to establish project priority. Closer links should also be established between farmers and public and private sector institutions, in order to improve horticultural production management and to avoid postharvest losses.

A survey designed to quantify the number of processing units required to produce value-added horticultural products, would be very useful. Home and cottage industry food processing for income generation should be developed at the community level, while formal training in food processing should be offered in educational institutions. Market information on processed foods demanded by overseas markets should be made available by Governments.

While it is true that losses vary according to season, they can be significantly reduced through the use of by improved containers and packaging materials. While many programs have focused on reducing postharvest losses in horticultural crops, progress has been slow. This is partly due to slow growth of the cooperative system and partly due to an overall focus on production, with limited attention being paid to postharvest activities.

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5. INDIA (1)

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INTRODUCTION

India with its current production of around 32 million MT, accounts for about 8% of the world's fruit production. Diverse agroclimatic zones in the country make it possible to grow almost all varieties of fruits and vegetables in India. Eight major varieties of fruits dominate India's export markets. These include mangoes, bananas, citrus fruits, apples, guavas, papayas, pineapples and grapes. Production of these fruits in India makes a sizeable contribution on a global scale (Figure 1).

Although India is the largest producer of fruits in the world, its production per capita is only about 100 g per day. Between 20 and 30% of total fruit production goes to waste owing to spoilage at various steps of the postharvest chain, reducing per capita availability of fruits to around 80 g per day which is almost half the requirement for a balanced diet. Fruit production in India has recorded a growth rate of 3.9% on an annual basis, while the fruit processing sector has grown at a rate of about 20% per annum. Growth rates have been considerably higher for the production of frozen fruits and vegetables (121%) and dehydrated fruits and vegetables (24%). Over 4,000 fruit processing units, with an aggregate capacity of more than 12 lakh MT (less than 4% of total fruits produced) exist in India. Approximately 20% of the production of processed fruits is exported, while the remainder is consumed by the defense sector, institutions and households. Mangoes and mango-based products account for 50% of exports (Anon, 2005).

India is the second largest producer of vegetables in the world, ranking next to China, and accounts for about 15% of global vegetable production. Current vegetable production exceeds 71 million MT and the total area under vegetable cultivation is around 6.2 million hectares which is about 3% of the total area under cultivation in the country. It is estimated that between 30 and 35% of India's total vegetable production is lost owing to poor postharvest practices. Less than 2% of the total vegetable production in the country is commercially processed as compared to 70% in Brazil and 65% in the USA. Approximately 1.5 lakh MT of vegetables is sold in the processed form.

Ten years ago, India exported 68,500 MT of processed vegetables, valued at Rs.160 crore (1 crore = 10 million). Since then exports of processed vegetables have registered a compounded annual growth rate of 16% in volume and 25% in value. Onions account for about 93% (in volume) of the total export of fresh vegetables from India. The other major export items include potato, tomato, brinjal, beans, carrots, chillies and capsicum. Major export markets include the Gulf Countries, UK, Sri Lanka, Malaysia and Singapore. Though India ranks second in vegetable production in the world, the average yield for various vegetables is low when compared to that of other countries.

Land ceiling has been a major deterrent for the large scale cultivation of fruits and vegetables, especially in the organized sector. The large numbers of small captive orchards are insufficient to meet the requirements of the fruit processing industry. Potatoes, tomatoes, onions, cabbages and cauliflower account for about 60% of the total vegetable production in the country, and are significant in terms of world vegetable production (Figure 1). Vegetables are typically grown under field conditions in India, as opposed to being cultivated in green houses. Vegetable productivity in India ranges between 6 and 15 T/ha (Sidhu, 1998), while fruit productivity ranges between 4 and 35 T/ha (Anon, 2005).

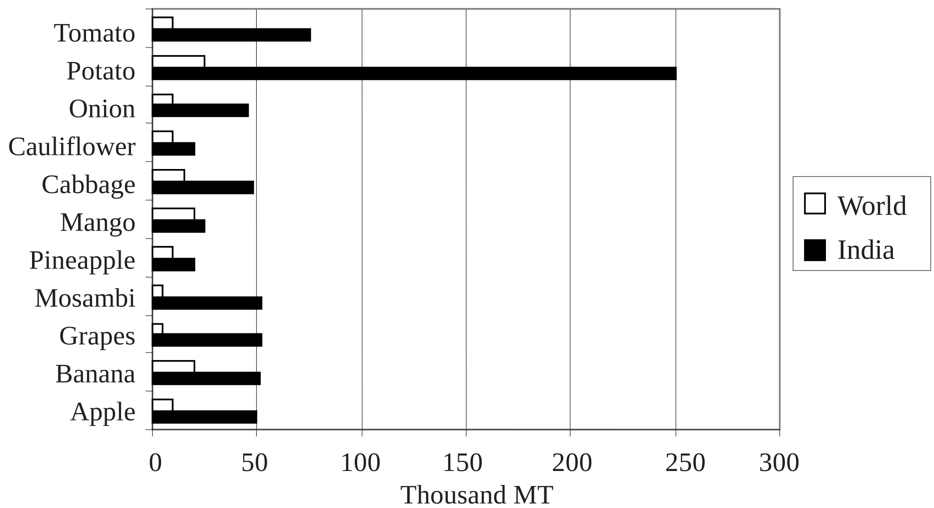

Figure 1. Fruit and Vegetable Production in India and the World (Kalloo, 1998; Kaul, 1996)

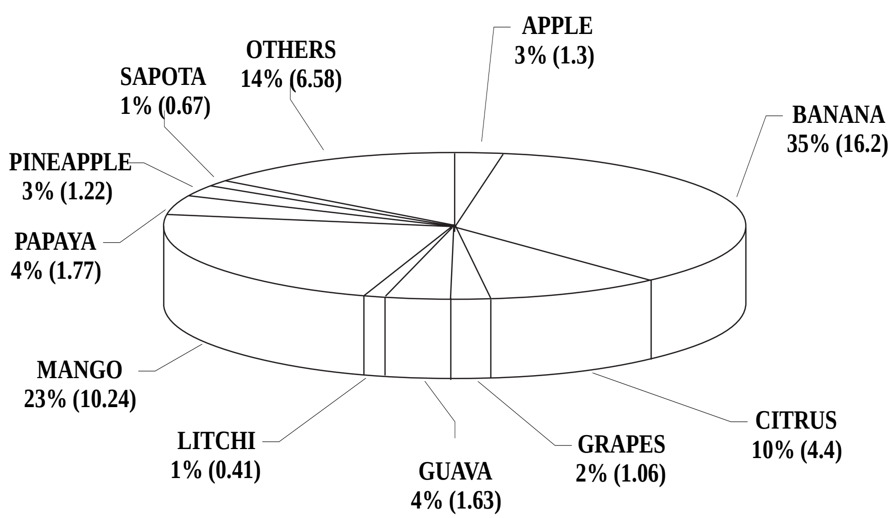

Figure 2. Production Share of Fruits in India (Jindal, 2004)

CURRENT STATUS OF POSTHARVEST TECHNOLOGY IN INDIA

Production and Postharvest Losses

During the last few years, considerable emphasis has been given to the production of horticultural crops in India. Accordingly, the area under fruit production increased by 172% during the period 1961 to 1993, and productivity per hectare nearly doubled (from 5.52 to 10.28 T/ha), resulting in a 320% increase in production. At the same time, considerable postharvest losses occur in fruits and vegetables, owing to the lack of suitable harvesting equipment, collection centers in major producing areas, suitable packing containers, commercial storage facilities, a cold chain and proper transportation systems. Losses in fruits are estimated to vary between 20 and 30%, valued at nearly 8,000 crores annually depending upon the fruit variety and the postharvest handling system. Astonishingly more than three lakh tonnes of cashews and millions of liters of coconut water currently go to waste. Pineapples and oranges produced in Asam are very poorly priced, owing to poor transportation and marketing facilities and to limited preservation capacity at the production site. Many other examples can be cited to illustrate the causes and levels of postharvest losses.

A recent study jointly conducted by the management consultancy firm, McKinsey & Co. and the Confederation of Indian Industry (CII), determined that at least 50% of the production of fruits and vegetables in the country is lost due to wastage and value destruction. The cost of wastage is estimated at Rs. 23,000 crores on an annual basis. Levels of wastage differ in accordance with the fruit or vegetable concerned (Anon, 1978).

Research Infrastructure

Postharvest research is currently conducted by the CFTRI, Mysore, RRL, Jammu and BARC, Mumbai, CSIR laboratory, Palampur and the DFRL, Mysore. Relatively little emphasis was given to research and postharvest technology in the ICAR system until the late seventies. An All India Coordinated Research Project on Postharvest Technology (AICRP) of horticultural crops was started by the ICAR in August 1978 through a PL-480 grant and four centers in the country (IARI, New Delhi; CMRS, Lucknow; IIHR, Banglore and YSPUHF, Solan). During the 6th plan the AICRP (PHT) was continued by the ICAR and was strengthened by adding four new centers, i.e., TNAU, Periyakalam, KKV, Dapoli, HAU, Hisar and ICAR-RC, Shillong during 7th and 8th plans, four more centers were added, i.e., BCKVV, Kalyani; MPKVV, Rahuri and RAU, Pusa, Bihar, bringing the total to 11 centers under the project.

Developmental Programs

A project on strengthening the postharvest infrastructure for horticultural crops was initiated by the National Horticulture Board in 1988–89. This project provided assistance in the establishment of grading/packing centers, retail outlets, cool stores, the procurement of plastic crates and transport vehicles. Facilities were also provided to provide access to market information, for the production of fruit juice/fruit based beverages, for the transfer of technologies through training and visits to growers, for the development of marketing infrastructure through soft loans and for the introduction of new technologies and concepts in horticulture.

Postharvest Loss Reduction and Postharvest Physiology

Chemical sprays have been utilized to reduce postharvest losses in different fruits. Examples of such chemical sprays include methyl thiophenate (0.05%) to control postharvest losses in Dashehari mango, pre harvest spray of 10–15 ppm gibberillic acid (GA) to enhance on-tree storage of mangoes by controlling maturity and delaying ripening; sprays of either benomyl, Topsin-M or carbendazim (0.05%) at 15-day intervals prior to harvest to control postharvest losses in Nagpur mandarin.

Maturity indices have been developed for mangoes, guavas, sweet oranges, grapes, litchis, apples, kiwis and stone fruits. The Bureau of Indian Standards (BIS) has recommended guidelines including maturity standards for bananas, which specify the number of days from flower emergence, pulp/peel ratio, color of pulp and odor. Fruits are generally manually harvested in India. Different fruits require different methods of harvesting. Mangoes, for example, are manually harvested with the use of bamboo poles to which a net is attached, and are lowered to the ground in a basket. Methods for harvesting fruits are standardized. Mature banana bunches are generally cut at the stalk end, citrus fruits are plucked manually, grape bunches are clipped with scissors, papayas are harvested by twisting the fruit till it snaps-off and Ber is harvested by shaking the tree. Ripening is the final phase in the development of the fruit. A considerable volume of information exists on the physical and chemical changes that occur during fruit ripening, particularly with respect to polysaccharide hydrolysis and levels of acidity. *Ethephon* at a level of 250 ppm applied during the color break stage in combination with berry thinning improved ripening and juice quality in Perlette and Beauty Seedless grapes. Postharvest dipping of Alphanso mangoes in an aqueous solution of ABA hastened ripening. Ripening in sapota is hastened by the application of *Ethrel*, 2, 3, 5-TP and *Maleic hydrazide.*

Storage

Storage losses of fruits in India are high owing to temperature and humidity conditions. Optimum refrigerated storage requirements for different fruits have been determined: 1.7–3.3°C for apples, 12.8°C for bananas, 0–1.7°C for grapes, 8.3–10°C for guavas, 8.3–10°C for mangoes, 5.5–7.2°C for oranges and 8.3–10°C for pineapples. When combined with low temperature, controlled or modified atmospheres markedly retards respiratory activity and delays softening, senescence and changes in the quality and color of stored fruits. The storage life of mangoes, for example, which is normally 6–10 weeks at 7–8°C, is increased to 10–16 weeks in 7.5% CO_2. Alphanso mangoes could be kept for 35 days at 8.3–10°C. Fruits could also be packed in polyethylene bags so as to create a modified atmosphere, i.e., one in which there is a high CO_2 level, for prolonged storage. A significant number of pre-cooling units as well as cool stores have been established in grape and mango growing areas and these facilities are being extended to marketing areas. Refrigerated containers are also being employed in the transport and shipment of mangoes and grapes for export.

Grading and Packaging

Mechanical grading of apples has been introduced in three states in India. Mechanical sizing is done either on a weight or a dimensional basis. The mechanical grading of the fruits is still in its infancy in India and grading equipment is either not available or has not been put to large scale commercial use. Traditional forms of packaging such as bamboo baskets, wooden boxes and gunny sacks are still widely used. Limited use is made of corrugated fibre board (CFB) boxes. Apart from being unhygienic, baskets do not allow adequate aeration and convenience of handling and stacking. Wooden packages are not conducive to the packaging of fresh fruits in view of the long term need of maintaining eco-systems. Corrugated fibre boxes, corrugated polypropylene board boxes, plastic trays/crates/woven sacks, moulded pulp trays/thermoformed plastic trays and stretch film and shrink wrapping are now being used.

There is also a need for the standardization of packaging technologies for fruits such as apples, plums and mangoes.

Processing

A number of technologies have been developed to satisfy demands of the processing sector. These include: dehydration technologies for the production of apple rings, cubes and chunks; juicing technologies for the production of concentrates from apples, plums, apricots, and kinnow; technologies for the debittering of kinnow juice and for the fermentation of cider, wine, vermouth, sparkling wine, medicinal wine and brandy, as well as technologies for the production of health foods, fruit based carbonated juices, osmo-canning of apples, osmotic dehydration of fruits, flavor extraction, and for the production of pectin from waste.

The various scales of processing employed in the food industry are summarized in Figure 3. During the last few years processing units employing state of the art technologies such as vacuum concentration, aseptic packaging, freeze drying and individual quick freezing (IQF) have been engaged in the processing of tomatoes, mushrooms, peas, cauliflower, juices, pulps and concentrates.

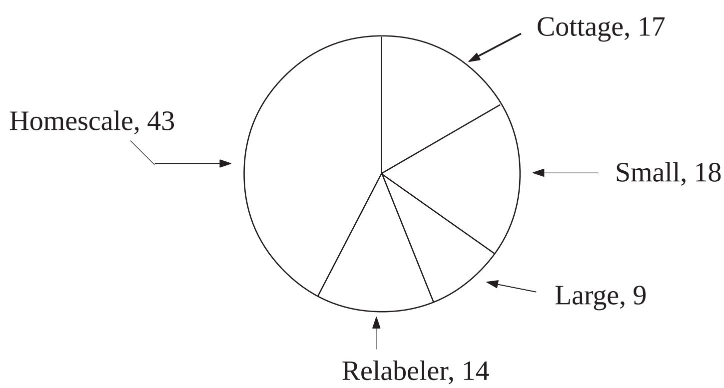

Figure 3. Distribution of FPO Licenses in India (Maini and Anand, 1996)

The nationwide commercial scale processing of mangoes, the processing of grapes in Maharashtra and A.P., and apples and stone fruits in H.P. and J&K is commendable. The establishment of a Horticulture Produce Marketing and Processing Corporation Ltd, (HPMC) in J&K and in HP and the establishment of a juice dispensing network throughout the country became a landmark in the apple industry. Raisin production has increased considerably (from 2,000 tonnes in 1984 to 12,000 tonnes in 1994). It is expected that India will be self sufficient in raisin production within the next 3–5 years. Improved techniques for the production of good quality raisins have resulted in an increase in the cultivated area of Thompson Seedless varieties. Another outstanding development in utilization of grapes is the production of Champagne (sparkling wine). Two factories, one at Narain Gaon (Pune) and the other at Pimple Gaon (Nasik) together produce 15 lakh bottles of wine. Grapes are also being utilized for the production of still wines and brandy. In H.P., an apple based winery has been successfully established for the production of cider, wine and vermouth. A continuous type of raw mango peeler has been developed for the production of pickles, chutneys and amchoor (dry mango powder). This peeler can be modified for the peeling of other texturally firm raw fruits such as papayas.

Low Cost and Eco-Friendly Technologies

An on-farm, low cost, environmentally friendly cool chamber, designated a Zero Energy Cool Chamber was developed in India, from locally available material. Temperatures within this chamber, which works on the basis of evaporative cooling principles, are reduced by as much as 17–18°C, with a relative humidity in excess of 90% during peak summer periods. This chamber increases shelf life and reduces wastage of bananas, mangoes, oranges, limes, grapes, tomatoes and potatoes in different situations in India.

A mango harvester, fruit peeler, hand and pedal operated cassava chipping machines, harvesting tools (which enhance efficiency by a factor of 5–14 times), coconut de husking machines, implements for the mechanization of potato cultivation and for the cultivation of other crops have been developed. A number of improved technologies have also been developed for commercial exploitation. These include tent-type foldable solar dryer, packing boxes for the distant transportation of apples, mangoes, citrus fruits and plums, the production of value added products such as pectin from peel and flour from mango fruit kernel, as well as the production of carbonated fruit beverages (Ghosh, 2005).

ISSUES AND IMPEDIMENTS TO MARKETING AND COMMERCIALIZATION

Several developments have taken place in fruit marketing in India. The National Dairy Development Board (NDDB) has, for example, established a large number of retail outlets for the sale of fresh fruits and vegetables in Delhi. Similarly in Bangalore City and in Hyderabad, entrepreneurs have established retail outlets which not only provide fresh graded fruits and vegetables to customers but which also offer several benefits to farmers. Various marketing societies also produce fruit juices for sale. Growth in the number of grower associations for the marketing of fruits and vegetables also provides a welcome departure from the conventional system. Marketing of graded fruits has greatly encouraged growers to produce fruits of better quality. Much has to be done with respect to fruit processing in the future.

Machinery and Equipment

Machinery and equipment are essential to the commercialization of any process or technology. Much of the equipment requirements for postharvest handling, including that for the food processing industry are manufactured overseas. Indigenous processing equipment is available only for small scale operations. Similarly, the choice of equipment for preparatory operations is very limited. The high cost of importing cans, has led to the development of indigenous electroplating technologies for the canning industry. Indigenous tin plate cans for open top sanitary (OTS) cans, are now commercially produced in India. The performance of fermentation equipment is, however, is yet to catch up with international standards.

Clean-in-place techniques, process automation and aseptic techniques for processing are yet to make their entry into the Indian food industry. The absence of such standard modern technologies accounts for the low level of development in India’s food industry. Lack of suitable machinery also poses a major hurdle to the adaptation and assimilation of laboratory scale technologies at the industrial level. The development of processing equipment is an area requiring research and development, if the industry is to grow to meet the requirements of domestic and export markets.

Market Emphasis

While fruits have been exported over several decades, their contribution to the generation of foreign exchange earnings has been emphasized, only in recent years. Recent emphasis on exports has, therefore, resulted in significant growth in fruit exports; both in volume and value (46,849 MT valued at Rs. 523.77 millions during 1990–91 to 78,506 MT during 1993–94). During 1993–94, 15,931.5 tonnes of grapes valued at Rs. 339.2 million were exported. Significant quantities of apples (5,987.6 tonnes), citrus fruits (6,807.35 tonnes), tamarinds (3,926.8 tonnes), pomegranates (2,623.23 tonnes) and sapota (2,007.93 tonnes) are exported.

Volumes of Indian fruit and vegetable exports vary on an annual basis, owing to changing scenarios in the international market and in accordance with requirements of the importing country. Fruit based alcoholic beverages offer potential for export and would make considerable use of fruit culls. India exported 1868 MT (6.15 crore) of dehydrated onions and 97 mt (0.28 crores) of dehydrated garlic, respectively for the period 1992–1993. Scope exists for considerably increasing India's export capacity.

POSTHARVEST MANAGEMENT PRACTICES FOR IMPROVING MARKETING

Controlled/Modified Atmospheric Storage/Packaging

Modified atmosphere (MA) storage essentially involves changing the normal atmospheric gas composition around a fruit or vegetable. In situations where this environmental change is strictly controlled with certain specific gaseous concentrations of N_2 CO_2 and O_2, it is termed "controlled atmosphere" (CA). Modification of the atmospheric environment for the packaging and storage of fresh horticultural commodities, involves either a reduction in O_2 levels or an elevation of CO_2 concentrations. The use of CA or MA should be considered as a supplementary practice to proper temperature and relative humidity management. Beneficial effects of CA and MA treatments include the retardation of ripening, senescence and physiological changes as well as the reduction of chilling injury. MA is effective in delaying the severity of postharvest infections, and is useful in controlling certain insects. Its limitations include irregular ripening, off-flavor development and the stimulation of sprouting, if not properly applied. The design and construction of controlled atmosphere storage, necessitates precise control. Controlled atmosphere environments must be relatively airtight, and equipped with reliable refrigeration systems and controls for the regulation of CO_2 and O_2 levels.

A gas blending system was designed and fabricated at IARI, New Delhi, for the CA treatment of horticultural produce. Suvernarekha mangoes can be stored up to 42 days under modified atmospheric packaging conditions with temperature manipulation. Further, pre-storage short term exposure to CA conditions doubles the shelf life of Amrapali and Mallika mangoes even under ambient conditions. The use of cling film in MA packaging delays senescence and extends the shelf-life of many fruits and vegetables.

Containerization

Although containerization was recently introduced into India, little use is made of containers for the national distribution of fresh horticultural produce. Potential, however, exists for the design of low-cost containers which employ ventilation and evaporative cooling. One of the greatest advantages of containerization is that containers can be transported either by truck or by rail. Palletization and containerization will go a long way in establishing national and international trade of horticultural produce.

Cold/Cool Chain

The cold chain has contributed tremendously to trade in fruits, vegetables and flowers in developed countries. Maintenance of low temperatures at different stages through the cold chain, results in the reduction of losses and retention of the quality of horticultural produce. While the introduction of a cold chain facility may not be immediately possible in India, attempts must be made to develop a cool chain by adopting the principle of evaporative cooling and other non-conventional methods of cooling.

Food loss reduction is less costly than an equivalent increase in food production. If efforts are not made to modernize the harvest handling system for horticultural crops, then postharvest losses will continue to have a negative economic and environmental impact. There is no doubt that postharvest food loss reduction significantly increases food availability.

It should also be noted that unlike expenditure on crop production which is an annual requirement, the establishment of postharvest facilities involves a one time capital investment which is compensated for, by the annual savings from postharvest loss reduction. A one percent reduction in postharvest losses could theoretically generate Rs. 230 crores on an annual basis, in India.

Freeze Dehydration of Fruits and Vegetables

While conventionally dried fruits and vegetables lose their structural integrity and exhibit poor rehydration characteristics, freeze-dried or dehydrated fruits and vegetables retain their nascent texture and color and reconstitute fairly rapidly even in cold water owing to their porous structures. Freeze dehydration can be thought of as an upscaling on lyophilization, a technique which is widely used in pharmaceutical and biotechnological applications to dehydrate and thereby conserve and preserve certain pharmacological and biological materials and formulations such as enzyme preparations, antibiotics, vaccines, various drugs, hormone preparations, microbial cultures, blood plasma and other products. Industrially, freeze dehydration runs in 2 cycles: freezing and drying. The product is initially frozen to a temperature of –10°C to –40°C depending on the nature of the biological material, following which moisture is removed from the frozen solid matrix under vacuum conditions (of the order of 100–200µ or negligible atmosphere) at a relatively low drying temperature (40–60°C) without allowing the solid matrix to melt in between, i.e., moisture undergoes sublimation from the solid phase to the vapor phase (Shah *et. al*., 2000).

Freeze-dried fruits and vegetables are often hygroscopic in nature and require packaging under controlled conditions of humidity (usually, below monolayer) and temperature (15–20°C). They are generally microbiologically stable and remain shelf-stable under ambient conditions for more than one year without spoilage when properly packaged. Polymeric films with aluminium foil, which provide adequate barrier protection against oxygen, water and light are best suited for the packaging of freeze dehydrated fruits and vegetables and beverage mixes.

Although the quality of freeze-dried foods is impeccable and unmatched when compared to foods dried using other dehydration techniques, freeze drying is not widely used, owing to its energy intensiveness and slow rates of drying. Processes have been standardized in India for the freeze dehydration of many types of fruit pulps, juices and slices in pilot scale freeze dryers and their stability, rehydratiblity, changes in pigment and vitamin content and sensory characteristics have been extensively evaluated. Mangoes, pineapples, citrus, apples, bananas, papayas, guavas, plums, tomatoes watermelons and avocados are amenable to successful dehydration. Ready-to-reconstitute sweetened beverage mixes based on pineapple, mango and mosambi have also been developed. Various green leafy and other vegetables in pieces or purees can be freeze-dried for incorporation into dietetic foods. Technologies for the production of freeze-dried mushroom and mushroom soup powders have also been developed.

Many tropical and subtropical exotic fruits, such as litchi and strawberry have excellent export potential in the freeze dried form. The true potential and opportunities of freeze drying remain to be fully tapped in India.

SAFETY IN THE POSTHARVEST MANAGEMENT OF FRUITS AND VEGETABLES

Food safety regulations have been implemented by various Ministries and/or Departments within India. These regulations serve two main purposes: 1) regulation of specifications for foods, and 2) regulation of hygienic conditions of processing and/or manufacturing. Some of these food safety regulations are mandatory while others are voluntary:

a) The Prevention of Food Adulteration Act (PFA) implemented by the Ministry of Health, outlines specifications for various food products and is mandatory.
b) The Agriculture Produce (Grading & Marking) Act implemented by the Ministry of Rural Development is voluntary. This particular act set forth the specifications for various agricultural commodities including some processed foods.
c) The Bureau of Indian Standards (BIS) is the largest body responsible for the creation of standards for various food products. BIS standards are voluntary.
d) A number of quality control orders have been issued under the essential Commodities Act. These include the Food Product Order (FPO), Milk and Milk Products Order (MMPO), Meat Product Order and Vegetable Oils Control Order. These orders are mandatory and are mainly meant for regulating hygienic conditions.

The Fruit Products Order

The Fruit Products Order-1955, promulgated under Section 3 of the Essential Commodities Act, 1955, aims to regulate sanitary and hygienic conditions for the manufacture of fruit and vegetable products. Licensing under this Order lays down the minimum requirements for:

1. Sanitary and hygienic conditions of premises, surroundings and personnel
2. Water to be used for processing
3. Machinery and equipment
4. Product standards

Maximum limits of preservatives, additives and contaminants have also been specified for various products.

This Order is implemented by the Ministry of Food Processing Industries through the Directorate of Fruit & Vegetable Preservation in New Delhi. The Directorate has four regional offices located at Delhi, Mumbai, Kolkata and Chennai, as well as sub-offices at Lucknow and Guwahati. Officials of the Directorate undertake frequent inspections of manufacturing units and draw random samples of products from the manufacturers and markets which are analyzed for their conformity with the specifications laid under FPO.

The Central Fruit Products Advisory Committee consists of officials of concerned Government Departments, technical experts, representatives of the Central Food Technology Research Institute, the Bureau of Indian Standards, Fruit and the Vegetable Producers and Processing Industry, is responsible for recommending amendments to the Fruit Product Order.

In view of the demands of the industry, the liberalized economic scenarios and consumer interest, some amendments were made to the Fruit Product Order in 1997 and 2000.

However, in order to enhance product quality and competitiveness and to facilitate the development and manufacture of innovative products, existing product specifications were amended specifications were created for new products. Draft specifications in respect of 61 products have been discussed by the Central Fruit Products Advisory Committee and recommended to the Government for adoption. The rules under the Fruit Product Order are also under revision.

Codex Alimentarius

Codex Alimentarius is a Latin term, which means food code. Codex Alimentarius brings together the collaboration of technical experts, scientists, governments, consumers and industry representatives to assist in developing standards for food manufacturing and trade. The standards, guidelines and recommendations of Codex Alimentarius are recognized worldwide for their primary role in protecting the consumer and in helping to bring about international trade. Since Codex Alimentarius represents a consensus of food and trade experts from around the world, its standards are increasingly being used in international trade negotiations and in disputes, by the WTO. The Codex Alimentarius contact point in India is the Directorate General of Health Services (DGHS) which is situated in the Ministry of Health. The Ministry of Food Processing Industries is closely associated with the activities of Codex Alimentarius (Source: USDA, Gain Report, 2000).

Hazard Analysis and Critical Control Point (HACCP)

India has instituted Hazard Analysis and Critical Control Point (HACCP) as an important element of its quality assurance systems. HACCP ensures that products are safe and of good quality. HACCP systems are extremely important as a part of the changing quality requirements in international trade. The Ministry of Food Processing Industries provides grants which cover up to 50% of the cost toward the implementation of Total Quality Management (TQM), which includes HACCP certification (Gupta, 2005).

Centralization and Jurisdiction of Local Agencies

A number of food analysts and food inspectors in India are mandated to assist consumers with food poisoning or food contamination concerns. Food Inspectors collect samples for analysis by the public analyst and the local (health) authority (LHA). In situations where food samples are adulterated, the vendor, manufacturer, distributor, or business is prosecuted by the LHA. Should the need for sample testing by the Central Food Laboratory, arise, samples are forwarded by the LHA to the court within five days. Public analysts provide food testing services for a fee. If the food is adulterated, the purchaser is entitled to reimbursement. Whenever a consumer suspects any defect, this defect should be immediately reported to either the food inspector or sanitary inspector area or to the health officer responsible for the location.

The consumer is also protected against monopolistic and restrictive trade practices. These are prohibited under the Monopolies and Restrictive Trade Practices (MRTP) Act, 1968. The Indian Standards Institutions (ISI), lays down voluntary national standards for commodities, materials, practices and processes. A large number of industries employ the ISI mark as a token of quality. India now has a National Federation of Consumer Organizations supported by the government. At least five or six of these organizations (The Banyan Tree) exist in Delhi.

FUTURE OUTLOOK

Greater emphasis must be placed on problem oriented research which employs integrated approaches to solving postharvest issues. Apart from missing links in our understanding and implementation of postharvest technology, proper linkages must be established with the processing sector. While mechanical harvesting of horticultural crops increases efficiency, it results in considerable wastage. Attention must therefore be given by food scientists and engineers, to the development of techniques which minimize wastage. Hygienic handling of raw materials and proper sanitation of equipment necessitates continuous assessment. Innovations in postharvest technology and particularly in the development of infrastructure could help achieve this goal. The processing of fruits and vegetables for export and for domestic markets requires utmost attention in developing countries. Efforts have been made for a quantum jump in the utilization of fruits and vegetables by the processing industry. Standardization of maturity indices for the harvesting of fruits and vegetables in order to control raw material quality prior to processing is needed. Waste generated by processing factories must be put to profitable usage, either through conventional technologies or through the adoption of biological processes (Verma and Joshi, 2000).

The quality and safety of fruit and vegetable products (freedom from microbial toxin and the pesticide residues) must continue to receive greater attention in view of its significant implications for human health. Attention must be paid to maintaining the microbiological quality of processed products and to the development of realistic standards including rapid microbiological methods to ensure food safety. Diversification of the processed product base, including the production of low alcoholic fermented beverages to make use of surplus quantities of fruit, could be one of the several approaches to reduce the postharvest losses in developing countries. Beverages of this type are gaining popularity in view of their role in coronary heart disease. Apart from emerging technologies such as high electric field pulses, oscillating magnetic fields, intense high pulses, high pressure treatments, ohmic heating, irradiation processing, modified atmospheric packaging, edible coating, low calorie substitutes for fat replacement, solid state fermentation, and biotechnological approaches must be assessed and assimilated by the food industry for success in the future (Arya, 1998).

CONCLUSION

India has a good resource base, adequate research and development infrastructure and excellence in several areas of horticultural interest. Production and postharvest processing activities within the country have, therefore, been changing at a rapid rate. The demand for horticultural produce in India is on the rise, owing to increasing populations, changing food habits, the nutritional value of horticultural crops and a greater emphasis on postharvest management, processing and value addition. Advantages of growth can be harnessed with well planned strategies, so as to ensure a positive future outlook.

Food safety is of growing importance in food production, processing and marketing. Investment in food safety, while assuring risk-free ventures related to horticulture, will increase the cost of fresh produce and the processing of fruits and vegetables. Efforts geared toward improving production technologies for fruits and vegetables will become meaningful only if the effective postharvest technology is developed and wastage is reduced. *Furthermore, unless the horticultural industry is linked directly with the processing industry, neither the consumers nor the producers can benefit.* Thus, proper growth of postharvest technology of fruits and vegetables is vital for development of India’s economy.

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6. INDIA (2)

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INTRODUCTION

Postharvest technologies are applied in the quality maintenance, conservation, processing, packaging, distribution and marketing of fresh agricultural produce. These technologies stimulate agricultural production, reduce losses, improve nutrition and add value to products, thereby generating employment, reducing poverty and stimulating growth within other related economic sectors. Inter-disciplinary and multi-dimensional approaches must be taken to the development and application of postharvest technology. These approaches must integrate consideration for political will, as well as for scientific creativity, technological innovation, commercial entrepreneurship and inter-disciplinary research and development, all of which must respond in an integrated manner to developmental needs. Building the appropriate socio-culturally oriented human resource base is fundamental to this type of development.

The importance of postharvest technology lies in its capacity to meet the food requirements of growing populations by reducing losses and increasing the production of nutritive food items from raw materials through processing and fortification. Postharvest technology also has the potential to create rural industries. In India where 80% of the population lives in the villages, 70% of whom are dependent on agriculture, the process of industrialization has shifted the food, feed and fibre industries to urban areas. This has resulted in a capital drain from rural to urban areas and has decreased employment opportunities as well as economic growth and development in the rural areas. There is a need for the development of appropriate technologies for the establishment of agriculturally based rural industries. The farmer, whose role has primarily been production, should engage in processing activities, thus increasing his earning potential.

STATUS OF POSTHARVEST DEVELOPMENT AND FUTURE VISION

Fruits

Postharvest, processing and packaging technologies for fruits such as mangoes, bananas, citrus, apples, guavas, papayas, pineapples and grapes are well established in India. Fruit production in India has recorded an annual growth rate of 3.9%, while, the fruit processing sector has grown at a rate of 20% per annum. Within the processing sector, the most significant growth has taken place in the production of frozen fruits and vegetables (121%) and dehydrated fruits and vegetables 24%. Over 4,000 fruit processing units exist in India with an aggregate capacity of more than 1.2 million MT. This capacity however accounts for less than 4% of total fruits produced. Approximately 20% of processed fruits are exported, while the remainder is used in the defense and institutional sectors and for household consumption. Mango and its products account for 50% of exports. Small captive orchards in India are insufficient to meet the requirements of the fruit processing industry.

Vegetables

India is the second largest producer of vegetables in the world and accounts for 15% of global vegetable production. Export of processed vegetables has registered a compounded annual growth rate of 16% in volume and 25% in value in recent times. Onions accounted for approximately 93% of the volume of exports. Potatoes, tomatoes, brinjal, cabbage, cauliflower, beans, carrots, chillies and capsicum account for approximately 60% of India's total vegetable production. The major export markets are the Gulf countries, the UK, Sri Lanka, Malaysia and Singapore.

MAJOR IMPEDIMENTS TO POSTHARVEST HANDLING

1. Lack of quality planting material for horticultural crops;
2. High cost of establishing plantation crops and fruit orchards which require a long gestation for production;
3. Low educational level coupled with poor technical training/extension facilities available to farmers;
4. Poor production technologies – rain-fed cultivation, improper planting, poor nutrition, irrigation systems, plant protection and IPM management**;**
5. Limited knowledge of maturity indices – stages of maturity, time and method of harvest;
6. Sorting and grading is done on a very limited scale, and is generally based on visual inspection;
7. Limited availability of pre-cooling facilities. Pre-cooling facilities are generally available for produce such as fruits (grapes, strawberries, and mango) cut flowers (rose, gerbera, carnation, anthuriums), and vegetables (potato, onion, tomato, capsicum) which are destined for export;
8. Lack of availability of transportation facilities dedicated to the horticultural sector;
9. Fresh produce shipped both within the country and overseas is improperly packed and transported;
10. Lack of a cold chain, inadequate storage and infrastructural facilities from the site of production to the point of consumption;
11. Lack of a network of local markets, and poor access to market information, results in unprecedented and unregulated arrivals in the local markets;
12. The unavailability of land for the large scale cultivation of fruits and vegetables has been a major deterrent in the organized sector.

INDIA's FOOD PROCESSING MARKET (2005–2010)

The Indian food processing market is very large in terms of production and consumption, as well as export and import prospects. New reforms in the country currently encourage commercialization. The country's food processing market is currently opening up to a wide range of investors across the globe.

Analysts anticipate that the total market for food processing goods in India will yield approximately USD69.4 billion in 2004–2005, of which value-added products will account for USD22.2 billion. Processed food exports and value-added agricultural products will witness further rapid growth in their respective industry segments in the coming years.

During the last decade, India moved from an era of scarcity to surplus, in the area of food production. India's food processing industry is consequently on an assured track of growth and profitability over the next five years. It is also estimated that the food-processing market in India will attract phenomenal capital, human, technological, and financial investment, amounting to in excess of USD32.1 million by 2010.

NEW TECHNOLOGIES DEVELOPED

Pre-Harvest Sprays to Reduce Postharvest Losses

Pre-harvest sprays of chemicals have been applied to reduce postharvest losses in different fruits. Thiophenate methyl (0.05%) was found to effectively control postharvest losses in Dashehari mango. A pre-harvest spray of 10 to 15 ppm giberellic acic (GA_3) proved useful for on-tree storage of mango by controlling maturity and delaying ripening. Three sprays of Benomyl or Topsin-M or Carbendazin (0.05%) at 15-day intervals before harvest were found to control postharvest losses in Nagpur mandarin. A pre-harvest spray of 0.6% calcium chloride, 10 to 12 days prior to the harvest improved the shelf life of grapes. An additional 2,720 kg/ha mango yield was obtained as a result of the pre-harvest spray of bavistin (0.5%). Use of GA3 50 PPM as a dip was found to induce seedlessness in gulabi grapes. Spraying of 2% urea on to banana bunches increased bunch weight by 2–5%. Pre-harvest heat treatment by reducing the ventilation in green houses increased the soluble solids content, fruit skin color and reduced the chilling injury of tomatoes. Application of 25% of etherel along with 2% urea in addition to 0.04% sodium carbonate of solution (50 ml) facilitated uniform flowering and fruiting in high density pineapple plantations. Growth of pole beans under green house conditions doubled the yield with quality pods.

Maturity Standards for Fruits

Mango

1. Slight color development of the shoulder or fullness of the shoulders; change in color pedicel from green to brown
2. Growth of the fibers on the stone/corrugations
3. Flow of latex from the stalk ex: faster drying latex
4. Summation of days taken from flowering to maturity by tagging flowers
5. Appearance of bloom on the surface of the fruits
6. Computation of heat units or cumulative degree days
7. Change in lenticel morphology
8. Specific gravity of 1.0–1.02 for Alphonso and pairi

Grapes

1. Heat unit concepts, e.g., 3200–3600 photo thermal units
2. Appearance of bloom on the berries
3. Color and condition of stem cluster
4. Taste - Brix-acid ratio 30–35
5. Composition of juice thick and consistent with 18–22% TSS
6. For raisins TSS should be 24–28%.
7. Compact clusters for table purpose, e.g., Thompson Seedless

Banana

1. Bunches are harvested when the top leaves starts drying
2. Change in color of the axis of the fingers dark green to light green
3. Brittleness of the floral ends should fall with slight touch

4. Changes in the angularity of fingers from triangular to round or sharp
5. Number of days from emergence of inflorescence: 95–110 days
6. Pulp to skin ratio – 120:1.2
7. Use of rings appropriate to variety

Jack fruit
1. Dull hollow sound is produced when the fruit is snapped
2. The last leaf of the peduncle turns yellow
3. Fruits spines become well developed and wide spread
4. Spines yield to moderate pressure
5. When fruit color changes from green to yellow
6. An aromatic odor develops
7. When the rind is fairly soft, flesh is crispy and pale yellow

Pineapple
1. When fruits show signs of yellowing
2. High TSS and low acidity (TSS 13%; acidity 0.5–0.6%)
3. Tips of the bracts projecting at the eyes start drying
4. Acid ratio 21–27 and specific gravity 0.98–1.02.5. When it emits a strong flavor, attains characteristic size and a translucent appearance
5. Summation of days – 4½ to 5½ month and may be judged by snapping with fingers

Papaya
1. Green for pickling and for the preparation of candy
2. Firm green, with moisture of 86% and TSS 10.67%
3. Ripe 33% for long distance market and 85.5%, color development for local market
4. Harvested when fruit show signs of yellow to purple color

Apple
1. Elapsed days from bloom to harvest (100–110 days) and development of abscission layer
2. Textural properties – Firmness, tenderness, starch and sugar content
3. Burst of internal ethylene production

Citrus
1. Change in color (green to orange)
2. Ease of separation
3. Starch content
4. Rate of respiration
5. Days from blooming
6. Seed-color (green to brown)
7. Change in organic acid
8. Juice content (>50%)

Maturity Standards for Vegetables

Tomato
1. Mature green, pink, or breaker and red ripe
2. Pulp surrounding the seeds is jelly-like, seeds slip away from the knife
3. For long distance shipment, is harvested at mature green stage
4. The ripe stage indicates that most of the surface is pink or red, and they are firm

Okra
1. Pods are still young, tender, exhibiting maximum growth
2. When the pods are readily shaped when they are picked
3. When mature pods are fibrous, and tough

Asparagus

1. Spears grow above the ground
2. They should be harvested when spear are not too long before tops begin to spread

Cauliflower

1. Head size and condition and before they become discolored, loose, ricy, blemished
2. Over mature flowers became too long flower stocks elongate, resulting fuzzy, ricy

Carrots

1. Size is the primary consideration and at least ¾ diameter
2. Proper color development without zoning

Peas

1. Sugar content > 5–6% in maturity sugar decline > Increase in starch/protein
2. Tenderness and appearance of pods – should be well filled with young tender peas
3. Changing in color from dark to light green with firmness of 5 kg/cm^2

Tools Developed for Mechanical Harvesting

Horticultural crops are generally manually harvested in India, owing to the low labor cost. Manual harvesting is particularly useful for those fruits and vegetables which require selective harvesting. Mechanical harvesting is applied to other crops in order to save on labor costs.

Mango Harvester

Cost-effective equipment for the quick and easy harvesting of mango with a pedicel length of 1–2 cm, was designed by the University of Agricultural Sciences in Bangalore. This equipment helps to prevent the flow of latex on to the fruit surface and thus prevents tissue damage.

Raw Mango Peeler

Between 25 and 30% of unripe mangoes are lost during fruit set and development in orchards, owing to weather conditions. These unripe mangoes can be processed into value-added products such as pickles, chutneys and dry powders. In order to facilitate their peeling, the Indian Institute of Horticulture Research in Bangalore has developed an integrated grader/peeler with a capacity of one metric ton/hour. A Kinnow mandarin clipper, chilly seed extractor, tamarind deseeding and sheeting equipment, a cassava peeler, and coconut dehusker have been also developed by this institute.

Pre-Cooling

Pre-cooling technology is extensively applied in the postharvest handling of horticultural produce. Pre cooling of mangoes to 12–15°C with 500 ppm Bavistin has been shown to increase their shelf life. Exposure of flowers to a temperature of 2–4°C prior to cold storage, results in prolonging their quality and shelf-life.

Grading

Systematic grading coupled with appropriate packaging and storage, will extend postharvest shelf life, wholesomeness, freshness, and quality, and will substantially reduce losses and marketing cost. Horticultural produce must be sorted and graded on the basis of parameters such as maturity, size, shape, color, weight, freedom from insects and pests, pesticide residues and ripeness.

Mangoes are graded for export on a weight basis as: Class A (200–350 g), Class B (351–550 g) or Class C (551–800 g). Grapes bunches are classified as Class (150–300 g), Class 1 (551–800 g). or Class 2 (75–150 g) with a preferred berry size of 16 mm and above. Pineapple fruits are graded in accordance with their weight as follows: A (1.50 kg and over), B (1.10–1.50 kg), C (0.8–1.10 kg), D (800 g) and baby (550 g). Papaya fruits are graded to size typically in counts of 8, 10 and 12 in to 3.50 to 4 kg net weights. Vegetables like onion, potato, tomato, chillies, okra and french beans are graded on the basis of size, shape, weight and maturity stage.

Packaging and Transportation

Large quantities of mangoes, bananas, oranges and other fruits and vegetables are transported in open trucks. Window type conical bamboo baskets designed for stacking and aeration have been developed by the CFTRI, Mysore for transportation of produce by rail.

The use of polyethylene film bags for wrapping whole bunches of bananas for transport, has been found to be most suitable for reducing wastage. The use of wooden crates having internal dimensions of 42x32x29 cm has also been recommended for the long distance transportation of bananas. Mandarins can either be individually wrapped in cling films or are packed in consumer packages such as plastic bags, plastic mesh, trays of moulded pulp, paper board, plastic, or foamed plastic. Losses in first grade tomatoes can be reduced from 15 to 3% by using upright cone baskets together with dry grass as a packaging material between the layers of fruits. Packing of tomatoes in sealed unventilated polyethylene provides a modified atmosphere which extends storage life. Printed plastic bags are used to reduce light transmission to potato tubers. Plastic oven ventilated bags of 25 and 50 kg of capacity are used for onions and potatoes. Palletization and containerization will go a long way in establishing both internal and international trade on a firm footing.

Storage

Storage life is governed by several factors. These include variety, stage of maturity, rate of cooling, storage temperature, relative humidity, rate of accumulation of CO_2, prepacking and air-distribution systems. Optimum refrigerated storage requirements for different fruits are as follows: 1.7–3.0°C for apple, 12.8°C for banana, 0–1.7°C for grapes, 8.3–10°C for guava, 8.3–10°C for mango, 5.5–7.2°C for orange and 8.3–10°C for pineapple.

Edible Coatings

Composite coating of polysaccharides (cellulose, pectin, starch, alginate, and chitosan), proteins (casein, soy) and lipids (waxes, mineral oils) have been extensively used in controlling spoilage of fruits and vegetables. Antioxidants such as BHA and BHT are added to protect against oxidative rancidity, degradation and discoloration.

Value Addition

In recent years the processing sector has been a sunrise industry in converting produce to value added products, particularly from less known fruit and vegetables because of their nutritional and therapeutic properties. New products of commercial value include amla candy with a sugar content of 78%, dried chips with a moisture content of 8%, squash with 25% juice and 40°Brix, lime blended squash in the ratio of 1:1 having 25% juice with 45°Brix were most acceptable. Bael fruit nectar is prepared by blending the pulp (15%) with sugar and acid (0.3%), while the squash is produced using 30% pulp with 50°Brix and 1% acidity. Bael fruits slab were prepared by adding 10% sugar with 1500 ppm SO_2 and dried to a moisture level of 14.5%. Fruit toffee of beal was made commercial with a recipe of 40% sugar, 10% skimmed milk powder and 6% edible fat. Custard apple, ber, papaya, passion fruit, jamun, kokum, phalsa, pomegranate, muskmelon, water melon products were developed and commercialized.

Minimal Processing

Minimally processed products are convenient ready to use or ready to eat fruits and vegetables with fresh-like quality and containing natural ingredients. Fruits such as pomegranates and vegetables such as carrot, beans, cauliflower, cabbage, okra and tomato are cut, diced or shredded to uniform size for commercial markets.

PUBLIC SECTOR ORGANIZATIONS INVOLVED IN THE POSTHARVEST MANAGEMENT OF HORTICULTURAL CROPS

Efforts are currently underway to create suitable infrastructure for postharvest management of perishable commodities. The following organizations have developed research and development projects and schemes designed to prevent postharvest losses and to integrate crop production:

1. National Horticulture Board (NHB)
2. Agricultural and Processed Food Products Export Development Authority (APEDA)
3. National Dairy Development Board (NDDB)
4. National Cooperative Development Corporation (NCDC)
5. Ministry of Food Processing Industries (MFPI)
6. National Medicinal Plants Board (NMPB)
7. Indian Council for Agricultural Research (ICAR)
8. National Bank for Agriculture and Rural Development
9. Commodity Boards - Spice, Coffee, Coconut, Agmark, etc.

Schemes Operated by Different Organizations

1. Research and development related to production, postharvest management and processing for domestic and export market
2. Scheme of feasibility studies, surveys, consultancy and database upgradation
3. Assistance for purchase of specialized transport units for horticulture
4. Setting up of mechanized postharvest handling facilities and sheds for grading, sorting, quality control and packing
5. Assistance to exporters, producers, growers/co-operative organizations and federations for establishing pre-cooling facilities
6. Development of cold chain technology and establishment of pilot plant
7. Assistance to exporters, producers trade associations, public institutions etc. for setting up strengthening of quality control activities and laboratories with food safety
8. Export promotion, human resource and market development

Strategies Needed by Scientists

- Application of conventional and biotechnological processes to the development of improved varieties having high production potential with high quality attributes and resistance to biotic and abiotic stresses;
- Research into mechanization of the processing of unexploited indigenous as well as exotic crop species;

- Research into farm level postharvest handling and simple storage systems;
- Diversified and economic methods of utilizing fruits and vegetables and processing of their wastes;
- Research on traditional Indian foods with commercial value;
- Studies on biodegradable and zero oxygen permeability packaging materials;
- Development of economical methods of monitoring temperature and relative humidity in CA/MA/MAP/Low pressure storage;
- Technological improvement of the minimal processing of fresh produce.

Strategies Needed by Growers

- Adaptation of the technique of high density planting in order to increase productivity and quality, for crops such as mango, pineapple, banana, tomatoes, onion, potatoes, etc.;
- Efficient land and input use programs – arid cultivation, fertigation, water harvesting;
- Mechanization of efficient harvesting techniques particularly for large orchards and plantations. Knowledge on postharvest biology of the produce.

Strategies Needed by Industries

- Technologies, industrial plants and machinery must be designed to suit the processing requirements of available raw materials at specific locations;
- Facilitate industrialization in production centres;
- Industry should make provision for guaranteeing stable prices to horticulturalists and reliable supplies must be provided at a reasonable price to the consumer;
- Improvement of low cost appropriate packaging material;
- Focus on the utilization of the wastage from the processing industry as by products.

CONCLUSION

Postharvest management and technology adoption is a continuous uninterrupted active process undertaken by a chain of researchers, extension workers, growers and end users. Consideration must therefore be given to the following by planners, administrators and other concerned:

- Encourage the corporate sector to undertake contract farming of crops to keep away multiple intermediaries between grower and processor;
- Replicate the Safal market of Bangalore in other locations of the country to achieve backward, forward and terminal marketing of produce;
- Establish farm level zero energy cool chambers and expand the use of cold chains for transport and storage;
- Introduce private and corporate entrepreneurs in sharing investment in the establishment of efficient marketing systems;
- Create an on-line marketing information system;
- Increase the number of AEZ/SEZ for export oriented crops like mango, banana, grapes, pomegranate, gherkins, onion, potato etc., in the country. Including small and marginal farmers who lack market power for merchandising their produce;
- Training of farmers through institutions, universities, NGO’s and Government agencies on Field Assessment of Quality (FAQ) crops for export. Integration of horticulture with agro rural tourism.

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7. INDONESIA (1)

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INTRODUCTION

Indonesia is a tropical country, which is divided into 32 provinces and consists of number of islands. Each province produces fruits and vegetables which are suited to its agroclimatic conditions. High ambient temperatures in Indonesia promote high respiration rates in agricultural produce. Postharvest losses in fruits and vegetables in the country vary between 20 and 50% (Budiastra, 1995).

Fruits and vegetables are essential constituents of a balanced diet. Recommendations of the Food and Agriculture Organization (FAO) indicate a daily requirement of 65.75 kg/capita/year of fruits and vegetables. In 2001, the level of fruit consumption in Indonesia was a mere 32.7 kg/capita/year, whilst vegetable consumption was lower, at 23.6 kg/capita/year. Table 1 shows consumption levels of fruits and vegetables in Indonesia and elsewhere.

Table 1. Consumption of Fruits and Vegetables in Indonesia and in Other Countries

Country	Vegetable consumption (kg/capita/year)	Fruit consumption (kg/capita/year)	Income per capita USD
Indonesia	23.6	32.7	640
Philippines	63.3	67.7	1,050
Thailand	30.3	92.3	2,160
Malaysia	28.9	51.9	3,670
U.S.A	106.4	50.4	29,240
Japan	106.5	58.7	32,350

Source: Hortikultura (2004)

Fruits and vegetables are consumed in both fresh and processed forms in Indonesia. They are produced primarily by small farmers on land holdings of less than 1 hectare.

This paper discusses the current status of fruit and vegetable production and efforts geared toward reducing postharvest losses in Indonesia.

FRUIT AND VEGETABLE PROCESSING INDUSTRY IN INDONESIA

A number of value-added products are produced from fruits and vegetables in Indonesia. Processed fruit products include banana jam, dried fruit, juices, sweets, *dodol*, chips, whilst processed vegetables are marketed in the form of dried vegetable products, chili powder etc. Indonesia’s agro-industrial sector consists of 345 fruit processors, 160 vegetable processors and 121 other categories of processors.

MANAGEMENT OF THE POSTHARVEST HANDLING OF FRUITS AND VEGETABLES

Fruits and vegetables are generally harvested by farmers with the use of simple equipment such as sickles, scissors, and punting-poles, equipped with a bag or cage at the top. Harvesting is generally conducted at the correct stage of maturity. Maturity is determined on the basis of visual or physical appearance or by counting the number of days after blooming or fertilization. Fruits are generally harvested from the plant by picking and transferred to a basket, following which they are emptied into a larger container and brought to the packaging station. At the packaging station, the fruits are cleaned, waxed, sorted, graded and when necessary, pest or disease control is applied. Vegetables are harvested by picking, following which they are transferred to a container for transport to the packing house where they are washed, withered, dried, sorted, graded and packaged (Purwadaria, 1995).

Fruits and vegetables are poorly handled after harvest, which leads to a very high level of deterioration. Poor handling is due to limited knowledge and consciousness of farmers and stakeholders as to the importance of postharvest handling and treatment. Financial constraints limit the ability of farmers to invest in equipment required for the postharvest treatment of fruits and vegetables. Many stakeholders have been trained in postharvest handling. Research has also been conducted to collect information and data on postharvest losses. Results of this research have not, however, been implemented.

INITIATIVES TO REDUCE THE LEVELS OF POSTHARVEST LOSSES IN FRUITS AND VEGETABLES IN INDONESIA

A Cold Chain Project was introduced by the Government of Indonesia in 2004, with the objective of reducing losses due to improper postharvest treatment of fruits and vegetables. Funded by the United States Department of Agriculture, this project focuses on developing cold chain networks from production to consumption. This project seeks to provide facilities for inter-island and even international trading of agricultural produce and fresh, cold and frozen foods. Winrock International, and Texas A&M University, are pioneers in the development of the cold chain for fruits and vegetables. Bank Mandiri, a national bank in Indonesia is the partnering institution in the financial sector. It is expected that this project will boost the export of local agricultural produce, and improve the quality of fresh and frozen agricultural produce.

The Indonesia Cold Chain Association (ARPI), a newly established non-profit organization, is also involved in the project. According to Muslim Faisal, Executive Director of ARPI, the distribution of chilled and frozen processed foods is still limited in Indonesia, and is affordable to a limited segment of the society. There are three reasons for this situation: Firstly, the importation of chilled and frozen foods is relatively new to consumers; secondly, the marketing of chilled and frozen foods in traditional markets is difficult; and thirdly, there is a serious problem in sustainably supplying frozen foods and perishable products to several regions, owing to limited infrastructure and knowledge of such products. To overcome this situation, APRI provides assistance in the development of logistics of a cold chain, from harvest to the consumer. This assistance targets reducing losses and improving the quality of fresh produce with the objective of maximizing benefit to the cold chain business in Indonesia.

APRI's activities also focus on reducing postharvest losses in fruits and vegetables. These activities should involve various institutions such as Department of Agriculture, Department of Trade, and research and development institutions, in order to enhance synergy. Given the tropical nature of Indonesia's climate, and the high respiration rates of fruits and vegetables under these conditions, the development of a cold chain is very important. It is expected that through this project, all fruits and vegetables will be stored at low temperatures to prolong their postharvest shelf-life. Unfortunately, this project has not involved all of the stakeholders. The introduction of this project is nevertheless, a step toward reducing postharvest losses in fruits and vegetables.

EXPERIENCE IN GUIDING GROUPS OF FARMERS IN PRODUCING SALAK AND PINAPPLE CHIPS

Initiatives to reduce postharvest losses in salak and pineapple have been taken in Sleman Regency of Yogyakarta, and in Ogan Komering Ilir Regency of South Sumaatera, respectively. These initiatives have introduced vacuum frying technologies to communities in these areas. This technology was expected to enable local farmers to reduce their postharvest losses by using surplus fruit for the production of chips.

Ingredients for the production of fruit chips were salak pondoh, pineapple and frying oil, while aluminium foil and cartons (paper board) were used for packaging. A vacuum fryer, spinner, sealer, knife, weighing machine, and container were the key pieces of equipment required.

The process and equipment were tested prior to transferring the technology to the field, in an effort to preempt problems during technology transfer. Success indicator targets for this project included: sustainable production after one year of introducing the technology, the number of pieces of equipment used in the region (either growing or not), existence of the product in strategic marketing areas, number of visitors to the production centres and mass media coverage. Other indicators were the number of invitations received by the group leader to participate in expositions and local Government initiatives to boost the development of small and medium enterprises (SME) and cooperatives.

In principle, a vacuum frying system is used for frying fruits while maintaining their texture, flavor and color. Frying under atmospheric conditions, leads to boiling of the oil at 180°C–200°C, thereby damaging the texture of the fruit by softening. The use of vacuum frying systems minimizes this impact by frying at lower temperatures (85°C–90°C), with little change in the texture, flavor and color of the fruit.

The vacuum fryer used in this project had a capacity of 10 kg, was compact in appearance, and was set on a rack.

Vacuum fryers were tested on six occasions prior to transfer of the technology to designated locations. The temperature varied between 85°C to 90°C whilst the frying time varied from 1 to 1.5 hours with a vacuum pressure of 40–70 mmHg.

Major steps in the production of fruit chips using vacuum frying technology are summarized in Figure 1, and include:

- *Preparation* Raw material is sorted in order to remove bad and damaged fruits. Raw material must be mature and be of a good physical appearance. Selection of raw material of high quality is critical to the quality of the final product. High quality raw materials will produce high quality chips.
- *Peeling* The selected raw material is then peeled, and the fruit flesh is retained. Peeling is not needed for fruits such as apples, melons and some other fruits. The fruit flesh is then cut into pieces as required.

- *Slicing* Fruit flesh is uniformly sliced to an appropriate size, form and thickness. The thickness of the chip is of particular importance, given that heat transfer is involved in the frying process. Uniformity in size and thickness of the fruit flesh will produce a product having uniform flavor, color and texture.
- *Frying* This is the main process in the production of fruit chip using vacuum frying technology. Before the fruit flesh is put into the fryer, the temperature (80°C–90°C) and pressure (40–70 mm Hg) of the frying chamber must be set. On attaining these set points, the fruit flesh is transferred to the fryer. During the frying process, water evaporates from the fruit flesh as is evidenced by marked bubbling of the water vapor in the oil. The frying process is terminated when bubbling ceases.
- *De-oiling* The fruit chips produced contain residual oil which is separated using a spinner. Chips are put into the basket of the spinner which is mounted on an axle, is cylindrical in shape and which has a number of small perforations. Under this basket is another cylindrical basket with solid walls that collects the oil. The spinner is operated at a high rotational speed so that the remaining oil on the chip is separated, and a dry and crunchy product is obtained.
- *Cooling* The chips are cooled in a chip room prior to packaging. The cooled product is then packaged.
- *Packaging* Vacuum fried chips have a water content of 3%. They are consequently hygroscopic and readily absorb water from the environment. In order to maintain the crunchy texture of the chips, they must be packaged as soon as possible after cooling. The chips are packaged in aluminium foil, following which they are transferred into carton boxes, secondary packaging material.

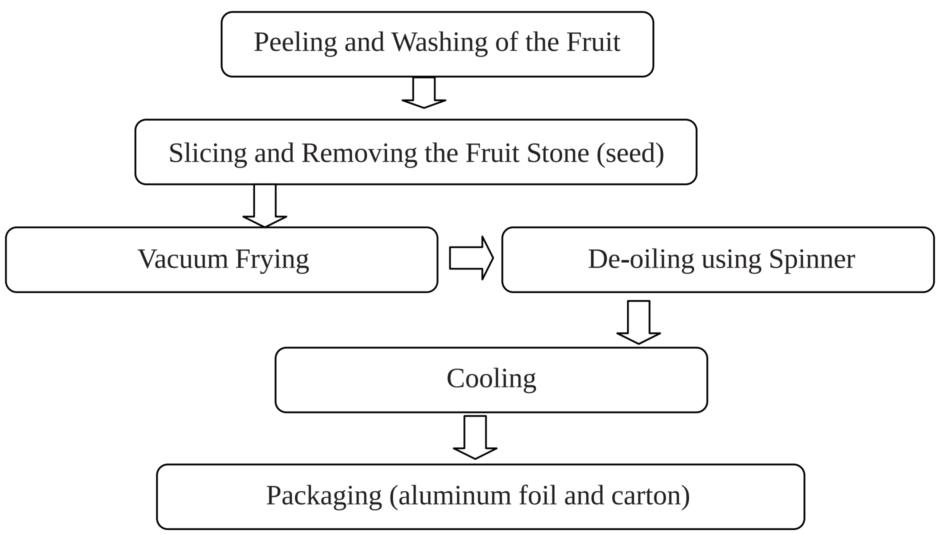

Figure 1. Process Flow Diagram for Producing Vacuum Fried Fruit Chips

An evaluation of the performance of the project in two locations, i.e., in Sleman (Yogyakarta) and OKI (South Sumatera), revealed that the project in Sleman showed better performance than that in OKI (Table 2).

These two projects have also been evaluated based on success indicators as mentioned earlier, and the result is presented in Table 3.

Table 2. Performance of the Vacuum Frying Project in Sleman and in OKI

No.	Parameter	Project in Sleman	Project in OKI
1	Name of Fruit	Salak Pondoh	Pineapple
2	Trade Mark	Krisa	Nasoki
3	Name of Group	Agro Makmur	Pinang Masak
4	Name of the Chairman	Sutrisno	Zainudin
5	Name of Village	Bangunkerto	Senoru
6	Total member	115 people	40 people
7	Other products	Salak syrup, fresh salak and dodol	Fresh pineapple
8	Year of the introduction	2001	2002
9	Contribution to BPPT	Profit sharing (two yimes give financial support); some samples were sent to expositions	No contribution
10	Marketing coverage	Jakarta, East Java Bali, and NTB, Malaysia (to be)	Very limited. Dependent on local government order only
11	Supply of raw material	No problem	No problem

Table 3. Success Indicators of the Two Technology Diffusion Projects

No.	Success Indicator	Salak Chip Krisa, Sleman	Pineapple Chip Nasoki, OKI
1	Production sustainability after one year of the introduction	Production process is sustainable	Production is discontinuous
2	Addition of equipment	Within one year the group managed to purchase one new set of equipment	No addition of equipment
3	Existence of the product in strategic marketing places	Product is sold in supermarkets and at the local airport	Product is scarcely found in supermarkets or in the local airport
4	Number of visitors	On average, 5 groups of visitors make a comparative study on a monthly basis	No visitors
5	Mass Media Coverage	Covered by electronic mass media on four occasions, and twice by newspapers	No mass media coverage
6	Local government attention/attitude to boost SME and cooperative	Very aggressive	Less aggressive
7	Manager ambition to progress	Very ambitious	Moderate

From Table 3 it is clear that the project on salak chips was more progressive than that on pineapple chips. This success was primarily due to management of the operations, at the technical level, as well as in terms of human resources, and marketing. The level of support received from local government in boosting the initiatives was also a major contributor to this success.

CONCLUSIONS

From the above description of the technology transfer projects, the following conclusions can be drawn:

1. High postharvest losses (exceeding 35%) in Indonesia are due to poor postharvest handling;
2. Currently, Indonesia produces 11,295,536 tons of fruit and 7,144,745 tons of vegetables;
3. In 2002, there were 345 fruit processors and 160 vegetable processors;
4. In 2001, approximately 21,400 tons of fresh fruit, and 113,400 tons of processed fruit were exported from Indonesia, while 240,400 tons of fresh fruit were imported;
5. A cold chain project was introduced by the Department of Agriculture in cooperation with Winrock International and Texas A&M University, in an effort to reduce postharvest losses in Indonesia;
6. The introduction of vacuum frying technology provided an opportunity to add value and to reduce losses in salak and pineapples;
7. The production of vacuum-fried salak chips was successful whilst that of vacuum fried pineapples was not.

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8. INDONESIA (2)

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INTRODUCTION

Horticultural commodities must be competitive both in quality and price. Competitiveness can be achieved through the launching of programs which integrate all stakeholders along the horticultural chain.

Development of the horticultural sub-sector is prioritized in Indonesia's framework for agricultural development, given the significant role of horticultural commodities in Indonesian food security, in enhancing farmer incomes, and in generating foreign exchange earnings. Horticultural programs geared toward providing capital to facilitate the development of competitive, sustainable, and farmer-based agribusiness development are being implemented in specific regions of the country.

Horticultural commodities produced in Indonesia include fruits, vegetables, ornamentals and herbs. The horticultural sub-sector contributes significantly to national economic growth and to farmer income at the local level. Vegetable farmers are generally better off than are farmers who produce other crops. Producers of fruits such as melons and watermelons which have a short season of production are able to maintain a better standard of living than those who produce fruits which require a lengthy season for production.

Problems encountered with production agriculture are more easily overcome than those experienced in the postharvest sector. The production of horticultural crops in Indonesia showed an increasing trend for the period 2001 through 2003. Fruit production increased from 9.96 million tons in 2001, to 11.7 million tons in 2002, and reached 13.6 million tons in 2003. Similar trends were observed for vegetables, the production of which increased from 6.9 million tons in 2001 to 7.1 million tons in 2002, and reached 8.6 million tons in 2003.

Despite this progressively growing trend in production, constraints to postharvest handling continue to be encountered. Considerable losses therefore occur in horticultural products. Budiastra (1995) reported losses of the order of 30 to 40% while Tridjaya (2005) reported losses of 10% for fruits and 9.6% for vegetables.

TRENDS IN THE IMPORT AND EXPORT OF HORTICULTURAL PRODUCTS

Indonesia is an exporter of both fresh produce and processed horticultural products. Fresh produce exports include rambutan, mango, pineapple, siam citrus, avocado, banana, vegetable leaf, paprika, tomatoes, mushroom, orchid, and ornamental plants. Pineapples, bananas, frozen vegetables, edamame soybeans, and baby corn, are examples of produce exported in the processed form. The volume and value of Indonesia's exports and imports of horticultural products during the period 2001 to 2003 are presented at Table 1.

Table 1. Horticultural Imports and Exports from Indonesia (2001–2003)

Year	Export		Import	
	Volume (kg)	Value (USD)	Volume (kg)	Value (USD)
2001	349,568,758	177,069,590	576,397,861	248,627,567
2002	383,801,313	197,920,648	619,019,066	325,915,295
2003	368,898,482	191,242,916	578,483,410	303,775,038

Source: BPS (2004)

As shown in Table 1, import volumes and value for horticultural produce exceed both export volumes and value. One major reason for this trend is the poor quality of Indonesian horticultural produce.

Fruit exports (208,969 tons) from Indonesia exceed vegetable exports (124,668 tons). Volumes of fresh vegetable exports exceed those of processed vegetable exports. In contrast, processed fruit exports, exceed fresh fruit exports (Table 2).

Table 2. Imports and Exports of Fruits and Vegetables and their Products from Indonesia (2001–2003)

Commodity	Year		
	2001	2002	2003
Export volume (kg)			
Ornamental plants	16,662,287	875,582	9,650,945
Vegetable	135,193,249	147,973,025	124,667,844
- Fresh vegetable	107,363,127	128,904,765	101,641,087
- Processed vegetable	27,830,122	19,068,260	23,026,757
Fruit	188,042,222	225,319,706	208,968,947
- Fresh fruit	21,428,110	31,124,058	30,086,127
- Processed fruit	166,614,112	193,195,648	178,882,820
Various plants	9,671,000	9,633,000	25,610,746
Total horticulture	349,568,758	383,801,313	368,898,482
Export value (USD)			
Ornamental plant	9,836,450	898,841	8,493,454
Vegetable	60,969,864	52,552,880	56,328,788
- Fresh vegetable	30,350,894	32,045,520	30,909,446
- Processed vegetable	30,618,970	20,507,360	25,419,342
Fruit	100,643,502	138,327,593	123,157,271
- Fresh fruit	9,366,353	27,880,247	36,418,666
- Processed fruit	91,277,149	110,447,346	86,738,605
Various plants	5,619,774	6,141,334	3,263,403
Total horticulture	177,069,590	197,920,648	191,242,916

Source: BPS (processed data)

Seasonality, quality and safety issues pose major constraints to the export of horticultural crops. Quality is assessed on the basis of: hygienic conditions, integrity of the skin, wholesomeness, evenness of color distribution, uniformity of size, and stability of flavor. Quality defects are the result of poor horticultural practices, small scale monoculture and/or low intensity of mixed culture and yard management. Seasonality is affected by planting patterns (production calendar), the harvest season, pricing, accessibility to and availability of distribution facilities, and transportation facilities.

Quality and seasonality problems result from poor production techniques, poor appreciation of quality attributes, limited availability of capital for the adoption of improved technologies and insufficient motivation for the application of new technologies.

POSTHARVEST MANAGEMENT FOR IMPROVED FOOD QUALITY AND SAFETY

Postharvest management to assure improved quality and safety is currently fraught with problems.

Losses and Quality

Losses in fresh horticultural produce are directly related to quality degradation. Quality loss is the result of improper handling and transportation of produce. A number of transaction sites referred to as terminals of agribusiness (TA) and sub terminals of agribusiness (STA) have been established at several sites in an effort to reduce losses and maintain the quality of fresh fruits and vegetables. These agribusiness terminal stations are intended to serve as sites for information exchange as well as a transaction points for buyers and sellers. Moreover, these stations are also used for sorting, grading, and packaging of produce.

Two TAs are currently operational in Indonesia, and a further 6 are currently under construction. Approximately 62 STAs are also operational. A majority of STAs are inadequately equipped with cold storage, washing, packaging and shipping facilities.

Packing houses have been constructed by a number of private sector entities in order to facilitate collection, sorting, and grading of fruits. Salak fruit produced at Magelang Regency, for example, are collected by farmer groups and graded into either of three classes: premium class (1 kg consists of 12–14 salaks), super class (1 kg, 15–17 salaks), and rejects (more than 15–17 fruit per kg). Premium and super classes of salak are transported by truck from Magelang to Jakarta over a distance of 500 km. Salak is packed in wood crates, having an average weight of 20 kg, and is sold at the Matahari Supermarket, which is a major player in the retailing of agricultural produce in Indonesia.

Postharvest handling requires knowledge of postharvest technology, proper facilities, and trained human resources. Poor postharvest handling in Indonesia is the result of limited facilities and low-grade human resources. Postharvest facilities for horticultural produce pale in comparison to those developed for other food crops.

Food Safety

Consumers demand fresh produce of good physical quality (appearance) which is safe. Efforts are currently being made to implement Good Agricultural Practices (GAP) on the farm in order to assure the safety of fresh produce in Indonesia. An Integrated Pest Management Program has also been implemented in order to minimize pesticide residues in horticultural produce. This program has been less than satisfactory owing to the poor discipline of farmers involved with the program.

A large number of households are engaged in the processing of horticultural produce. Several small and medium scale enterprises process fruit into concentrates, juices, chips, and other products such as jams, sweet dried fruit and banana flour. In 2002, 356 cottage industries distributed over 30 provinces, were engaged in fruit processing. These industries are facilitated by the Agriculture and Industry Departments and are supervised by the Food and Drugs Supervising Agency.

The Ministry of Agriculture provides assistance to processors of horticultural produce. The implementation of HACCP in food handling in Indonesia is still rather limited although a number of small and medium enterprises have begun implementing both GMP and HACCP. Indonesia through its National Standard Agency adopted HACCP in 1998 (SNI: 01-4852-1998). HACCP principles have been applied to a limited extent in the export of processed fish products. HACCP implementation in the fishery industry in Indonesia is supported by Canadian assistance aimed to increase the export of processed fish products to foreign countries. HACCP implementation was initially controlled by the Agriculture Department, but since 2001, has been controlled by the Department of Ocean and Fisheries Affairs.

Constraints

Access to seed poses a serious constraint for farmers. The land area available for fruit and vegetable cultivation also poses a constraint, since many farmers work on small holdings and lack economies of scale. Horticultural production generally employs the use of conventional technologies. Its outputs are, therefore, highly variable in quality.

Postharvest handling of fresh fruits and vegetables has a relatively insignificant impact on farmer income, given the low level of consumer demand for fruits and vegetables that have been cleaned, sorted and graded. Farmers are, therefore, reluctant to apply proper postharvest handling. Furthermore the insignificant price reward for produce quality often results in losses to the farmer when postharvest handling is done on an individual, rather than on a collaborative basis. A case study on banana marketing in West Java Province indicated that farmers were reluctant to adopt quality improvement technologies since there was no guarantee of improved prices (Setijadi *et al*., 2003).

A number of technical, social and economic factors constrain postharvest management in Indonesia. Major technical constraints include limited awareness and knowledge of farmers, poorly skilled workforce, limited facilities for the distribution of produce, and the inadequacy of postharvest equipment. The unavailability of cold chain systems also poses a serious constraint to the postharvest handling of vegetables. The main social constraints relate to farmer practice of conventional management and buyer requirements for uniform quality, which cannot be met by conventional farmers. Major economic constraints include high investment and daily operation costs. Entrepreneurs engaged in postharvest activities, generally lack capital. Furthermore, there are no government supported credit schemes to assist farmers in purchasing postharvest equipment.

SUCCESS STORIES IN POSTHARVEST MANAGEMENT

Case of the Bright Star Group

The Bright Star Group is a group of housewives engaged in the processing of fresh pineapples into chips in order to evade a decline in prices at the peak of the harvest season. During this period, fresh pineapple prices may decline to as low as IDR100 (USD0.1 cent) per piece. The production of chips, using vacuum frying technology, however, increases the price of pineapples to IDR500–750 (USD0.5–0.75 cents)/piece. Proper postharvest management practices are required to assure the quality attributes of the fresh pineapples for processing into chips. Furthermore, all unit operations, including peeling and cutting must be controlled. The frying temperature, duration of the frying process, and level of agitation during frying are also controlled. Fried pineapple is packaged in either aluminum foil or plastic. Product packaged in aluminum foil has a longer shelf life than that packaged in plastic.

The Bright Star Group has not fully implemented either HACCP principles or the Indonesian National Standard although it has made some attempts to do so. This Group has a production capacity 1 ton of pineapple chip per month, which necessitates 10 tons of fresh pineapples for processing. Marketing of the product is still limited to the Muara Enim Regency area. Approval from the Food and Drugs Supervising Agency is currently awaited for the Group to market its produce to other parts of the country. The Group has received some support from the local government. It has improved the income of small pineapple farmers, stimulating them to pay greater attention to their crops while providing fieldwork for local people.

Case of PT Haraka Kitri Endah

PT Haraka Kitri Endah (PT HKE) is a small-medium enterprise in East Java Province that produces aseptic purees from several tropical fruits, including sour sop, banana, tamarind, *Morinda citrifolia* (noni), mango, pineapple, and papaya. With the exception of pineapple which is only processed into juice, all of these fruits are processed into aseptic concentrates and juices. Papayas are processed on demand.

On average, between 1,500 and 2,000 tons of puree are produced, 75% of which is sour sop puree. Between 30 and 40% of the product is sold on the domestic market, while the remainder is exported. A majority of the buyers on the domestic market are foreign companies located Indonesia, which employ products from the PT HKE as a base. Products are exported to the USA, Caribbean, and to some Asian countries including Japan, the Republic of China, the Philippines, Malaysia, and Singapore. The USA is the largest export market for these products. PT HKE currently processes at least 7 different types of fruits.

In accordance with regulations governing the import of juice (including purees) into the U.S. market, PT HKE was required to implement the HACCP quality systems in order to maintain that market. Company representatives therefore undertook HACCP training offered by the Directorate General of Processing and Marketing for Agricultural Products and the Agricultural Service of East Java Province in Surabaya (East Java), leading to the successful implementation of HACCP quality systems in April 2004. PT HKE attained HACCP certification from the Mutu Agung Lestari, a quality system certification institution accredited by National Accreditation Committee.

Some benefits realized by PT HKE due to the application of HACCP quality system include:

- Market share in the USA and in the Caribbean were retained. Foreign owned companies in Indonesia who purchase products of the company were also retained;
- Improved competitiveness, resulting in the promotion products of the company by overseas buyers. In other words, the application of HACCP quality systems assisted the PT HKE in marketing;
- Improved confidence in coping with the field audit of buyers;
- Reduced levels of rejects;

- Increased consumer confidence and the ability to track errors through a good record keeping system developed by the Company.

Quality system certification institutions in Indonesia are independent institutions which are accredited by the National Accreditation Committee (NAC). Relatively few quality system certification institutions have been accredited by NAC to date. The Agricultural Department has plans for the development of a network of quality system certification institutions in order to establish quality management systems for agro processors.

CONCLUSIONS AND RECOMMENDATIONS

Indonesia's horticultural sub-sector contributes significantly to the food security of the country.

- Fruit and vegetable production shows an increasing trend;
- Postharvest management systems for horticultural produce in Indonesia are still inadequate.

Postharvest facilities are still very limited, given the considerable volumes of horticultural crops produced. There is consequently a need for a larger number of properly equipped facilities for postharvest handling, as well as for trained capacity in postharvest management.

Increasing the contribution of horticulture to national economic development will necessitate improvements in infrastructure, the development of farmer groups and partnerships, the application of appropriate technologies, awareness raising on food quality and safety issues, improved access to credit and the implementation of GAP, GHP, GMP and HACCP. Access to appropriate technology at production centers as requested by horticultural farmers is also necessary. Knowledge and skills in postharvest handling must also be developed.

Foreign investment and joint venture programs in agro-processing and related areas are required in order to stimulate the development of agro-processing in Indonesia. Foreign investment is currently encouraged by current government policy.

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INTRODUCTION

Iran with an area of 1,648,195 sq km is located in South West Asia. It is bordered by Turkmenistan, Azerbaijan and Armenia to the north, and shares common borders with Turkey and Iraq on its west side. Pakistan and Afghanistan are situated to the east of Iran. The country has access to the Caspian Sea in the north and to the Persian Gulf and Oman Sea in the south. More than 30% of Iran's land mass is bordered by sea. According to 2004 statistics, Iran had a population of 67.7 million of which 66.3% was urban and 33.7% was rural.

Rainfall levels across Iran average at about 240 mm with a highly uneven distribution across the country. Average annual rainfall at the borders averages around 50 mm while that in the northern regions is as high as 1,500 mm. The temperature gradient across the country is also very noticeable, with minimum temperatures in the mountains as low as -30^{0}C and maximum temperatures in the southern regions as high as 50°C. Iran therefore enjoys all four seasons simultaneously, with varied ecological conditions.

These climatic conditions coupled with varied soil types allow Iran to produce a diversity of agricultural crops, and contribute to the importance of the country's agricultural sector. In 2003, agriculture accounted for 11.6% of Iran's GDP while its share in employment and non-oil exports were 20 and 22% respectively.

FRUIT AND VEGETABLE PRODUCTION IN IRAN

In 2003, Iran's agricultural sector successfully produced more than 63 MT of farm crops, 14 MT of horticultural crops, 9 MT of animal products and 442,000 tonnes of fishery products. Approximately 26 MT of fruits and vegetables were produced by Iran in that year. Table 1 summarizes fruit and vegetable production in Iran in 2003.

Pistachios account for 61.1% of the acreage under fruits, while tomatoes account for 17.1% of vegetable production (Table 1).

Horticultural produce accounts for 57% in weight terms and 78% of Iran's total agricultural export value (Table 2). Pistachios with a share of 8 to 10% of total non-oil export are significant foreign exchange earners for Iran.

In 2004, Iran ranked second to India for fruit and vegetable production among APO member countries (Table 3).

Table 1. Acreage and Production of Major Fruits and Vegetables in Iran (2003)

Product \ Acreage and production	Total acreage (000 ha)	Total production (000 T)	Share of total F&V acreage (%)	Share of total F&V production (%)
Fruits				
Grapes	305.7	2,870.9	11.7	11.1
Apple	180.5	2,518.7	6.9	9.7
Date	230	964.7	8.8	3.7
Citrus	256.1	3,881.4	9.8	15
Pistachio	420.2	235.2	16.1	0.9
Vegetables				
Potato	173.2	4,209.2	6.7	16.3
Tomato	132.6	4,428.6	5.1	17.1
Onion	45.8	1,573.7	1.8	6.1

Source: Agricultural Statistics Yearbook, MOJA

Table 2. Export Volumes and Values of Fruits and Vegetables (2003)

Crop \ Export	Export volume (000 T)	Export value (million USD)	Share in total F&V export (%)	Share in total F&V export value (%)
Fruits				
Pistachio	173.2	667.6	16.8	63.7
Raisin	148.1	93	14.3	8.9
Date	116.5	34.8	11.3	3.3
Citrus	45.1	11.3	4.4	1.1
Apple	166	32.4	16.1	3.1
Vegetables				
Potato	37.9	6.1	3.7	0.6
Tomato	63	9.4	6.1	0.9
Onion & shallot	78.7	9.9	7.6	0.9

Source: Agricultural Statistics Yearbook, MOJA

Table 3. Fruit and Vegetable Production in Major APO Producing Countries (2004)

Country \ Production	Fruit	Vegetable	Share in total F&V (%)
India	46,971	80,261	54.3
Iran	12,724	11,955	10.5
Indonesia	13,120	6,557	8.4
Japan	3,778	11,798	6.6
Rep. of Korea	2,440	11,020	5.7
Vietnam	5,249	7,781	5.6
Thailand	7,521	3,164	4.6
Pakistan	4,987	5,108	4.3

Source: FAOSTAT (2005) and Author’s Calculations

POSTHARVEST HANDLING OF FRUITS AND VEGETABLES

Harvesting and postharvest handling of crops, play a critical role in assuring their price and quality. Improvement of postharvest quality and efficiency in the marketing system necessitates improved harvesting methodologies, training of farmers, as well as the use of appropriate facilities and equipment for transportation, packaging and storage. Specific steps of the postharvest handling chain are now described:

Harvesting of Fruits and Vegetables

Fruits and vegetables are manually harvested in Iran. Efforts have been made to use and extend modern methods of fruit and vegetable harvesting in Iran. Despite these efforts, manual labor is still widely used in fruit and vegetable harvesting. This heavy dependence on manual labor, often leads to problems associated with employment and wages.

Sorting

Fruits are generally manually sorted in the field, while vegetables are directly transferred to storage, without sorting.

Transportation

Fruits and vegetable are generally transported using vans, trucks, and on occasion, refrigerated vehicles. Mechanical injury during transportation often leads to considerable quality loss. Transportation is a major bottleneck in the marketing chain for fruits and vegetables.

Storage

Proper storage of fruits and vegetables is critical to enhancing their shelf-life. Limited availability of suitable storage compromises quality and leads to considerable wastage. Iran currently has 356 chilling chambers with a storage capacity of 806,500 tonnes. The Ministry of Jihad-e-Agriculture has established 14 chilling chambers consistent with its policy on developing proper storage facilities.

Packaging

Proper packaging of fruits and vegetables plays a key role in maintaining product quality, in protecting them against chemical and physical damage, in promoting their competitiveness and in making them available in a convenient format. The high cost of packaging, coupled with limited knowledge on the subject of packaging and the unavailability of suitable packaging have all been major impediments to Iran's fruit and vegetable export trade.

Iran's Fourth Development Plan, has therefore focused on enhancing the competitiveness of its produce on international markets. Projections are to increase the capacity of the citrus packaging and sorting industry from its current level of 20,000 tonnes to 200,000 tonnes at the end of the Fourth Cultural, Social and Economic Development Plan.

Processing

Processing adds value, creates employment, reduces waste and generates foreign exchange earnings. Iran has emphasized agricultural processing through codes and guidelines on the establishment of food processing industries. Currently a diversity of aquacultural, horticultural, farm and animal products are processed in Iran. At the end of 2003, approximately 2,500 units with a capacity of 1,225,000 tonnes were engaged in processing horticultural products, including grapes, pistachio and citrus.

Approximately 640,000 tonnes of grapes, 512,000 tonnes of apples, 415,000 tonnes of fruits and 200,000 tonnes of citrus are processed in Iran. According to projections of the Fourth Plan, the processing industry will produce 3,218,000 tonnes of produced products by 2009.

Approximately 795,000 tonnes of processed vegetable products including catsup, onion powder, and chips are currently produced in Iran.

One important policy which has operated effectively in developing and extending processing industries, and which presents a clear horizon, is the Plan for the establishment of Rural Industrial Areas, which was implemented in 1987. Within the context of this Plan, government funded studies are conducted to assess the potential for establishing industrial areas and for developing infrastructure, following which licenses required for the establishment of processing operations are given to applicants. The government provides incentives to stimulate the sale and export of products.

Wastes

Considerable volumes of agricultural crops produced in developing countries go to waste between their production and consumption points. Levels of waste vary between 30 and 35%. Approximately 7.6 MT of the 25 MT of fruits and vegetables produced in Iran go to waste. Significantly lower quantities of waste of the order of 7 to 10% are realized in developed countries. The most significant losses occur in strawberries (35–40%) while the lowest level of losses is realized in saffron (2–3%).

Losses along the fruit and vegetable chain result from:

- Improper packaging materials
- Improper collection methods
- Improper containers for the transportation of agricultural produce (waste at this stage is calculated at 3–7%)
- Limited availability of packing equipment (waste at this stage is calculated at between 3.5 and 5%)
- Limited availability of silos, and storage facilities (waste at this stage averages between 2 and 5%)
- Limited packaging facilities including packaging material and packaging equipment. (At this stage, between 2 and 3.5% of the produce is lost)
- Limited crop processing facilities (4 to 10% are wasted at this stage)
- Deficiency and inefficiency of the crop supply system
- At the final consumer who for a few reasons such as excessive purchase also contributes to waste (the estimation of wastes for this stage by the consumer is about 5.8%)

FOOD SAFETY

Food safety is the responsibility of the Standards Institute and the Ministry of Health. Efforts are currently underway to promote sanitary and phytosanitary standards and to align these standards with global standards and those of consumption markets. Codex Standards form the basis of food standards and are implemented through the formation of different committees. Iran is committed to the International Plant Protection Commission, for plant safety issues.

HACCP systems were implemented for pistachio production in 2003. Farmer training designed to raise awareness on postharvest issues has been supported by the Ministry of

Jihad-e-Agriculture. Since 1991, approximately 60,000 people have been trained. The Fourth Development Plan also focuses on producing healthy foods (using the least possible quantities of pesticide and fertilizers) through assuring crop safety.

ROLE OF PUBLIC AND PRIVATE SECTOR

Infrastructural requirements are administered to by the Government and are operated by cooperatives and the private sector. Currently more than 320 cooperatives are actively engaged in work on postharvest. These cooperatives are privately managed, but receive incentive support from the Government.

MARKETING EFFICIENCY

A number of studies on the marketing of agricultural produce including fruits and vegetables have been conducted in Iran. Research conducted on tomato and potato marketing revealed that the share of the producer in the final price varies between 36 and 40%. Inefficiency for potato has been estimated at 0.3 while that for tomato is 0.7.

POLICIES AND STRATEGIES TO IMPROVE POSTHARVEST HANDLING

The training of farmers is critical to improving quality and preventing waste. To this end, the Ministry of Jihad-e-Agriculture has conducted a number of training courses on postharvest handling for farmers and workers in small scale processing units. These courses are generally conducted in the form of short term courses on extension (2 to 3 days duration), and/or technical-vocational training courses (15-day courses). Topics of these training courses include:

- Training in drying technologies for farm crops
- Standard and scientific methods of storing, sorting, etc.
- Packaging
- Training in horticultural crop production
- Training in fruit juice production

Farm Days are convened during which experts and researchers transfer their findings to producers. Greater investment in transportation fleets and for the development of processing units is required. The provision of incentives and credit facilities can facilitate a greater contribution from both the private sector and cooperatives.

10. ISLAMIC REPUBLIC OF IRAN (2)

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INTRODUCTION

Iran is a predominantly agricultural country. Of its 51 million hectares of arable land about 19 million are under cultivation. One third of this cultivated land is irrigated. Low productivity in the country is due to the small plot size of many farmers (approximately 85% of the farmers own plots of less than 10 hectares) and insufficient water resources.

Total agricultural production in 1999 was approximately 61 million tons, of which 48.5 million tons consisted of agronomic crops and 12.5 million tons were horticultural crops.[9]

Large quantities of fruits and vegetables such as citrus and kiwifruit are produced in the Caspian Littoral which is situated in the northern part of the country. Apples are produced in the northwest, northeast and central regions, while pomegranate is produced in the central regions, and dates and vegetables are produced in the central and Southern regions. Pistachios account for the largest volume of export. Apples, kiwifruit, pomegranates and dates are also exported. Fresh vegetable production in 2001 was reported at 1,685,000 tons, while total fruit production stood at 14 million tons.

PRODUCTION AND LOSSES IN MAJOR FRUITS AND VEGETABLES IN IRAN

Globally, Iran is a major producer of fruits and vegetables and in some cases is considered among the top ten leading producers of fruits and vegetables.[1, 2]

Official statistical reports, however, show that more than 35% of this produce goes to waste on an annual basis. Postharvest losses in some fruit and vegetables in Iran are summarized in Tables 1 and 2. Losses in agricultural produce are due to: improper harvesting and transportation methods, unsuitable storage of products after harvest, poor sorting, improper packaging and distribution. Losses also occur during retail sale, consumption and processing. Upgrading of systems, designed to minimize losses could provide the country an opportunity to preserve its resources and to increase its fruit and vegetable exports.

Table 1. Postharvest Losses in Horticultural Produce in Iran[7]

Produce item	Losses (%)		Product	Losses (%)	
	Min.	Max.		Min.	Max.
Cucumber	15	17	Potato	18.5	21.0
Onion	16	18	Tomato	28.0	31.5
Melon	17	18	Strawberry	35.0	40.0
Watermelon	17	18	Saffron	2.0	3.0

Table 2. Losses in Fruit in Iran at Various Steps of the Postharvest Chain

Product	Losses of Harvest, Transport, Storage, etc. (%)					
	Harvesting	Transportation	Storage and sorting	Wholesale	Retail sale	Total
Apple	3–4	3–4	13–15	2	4	25–31
Almond	1	1	2–4	1	1	6–8
Citrus fruits	3	3	15–18	2	5	28–31
Date (Palm)	3	2–4	8–9	2	3	18–12
Figs	4	6–8	14–18	3	5–6	32–39
Grape	4–5	4–6	14–17	3	5–7	30–38
Kiwifruit	2–3	2–3	12–16	2–3	6–8	24–33
Pear	3–4	4–6	14–16	2	5	28–33
Persimmon	2–3	2–3	12–16	2–3	6–8	24–33
Pistachio	1	1	3–6	1	1	7–10
Pomegranate	2	1–2	15–17	2	3	24–27
Sweet cherry	3–4	3–5	14–17	2	4–5	25–33
Stone fruit*	3–5	3–5	13–17	3	5	27–35
Walnut	2	1	4–7	1	1	9–12

Source: Ministry of Agriculture, unpublished data[7]
* Apricot, Peaches, Plum.

The major factors which contribute to postharvest losses include:

1. Lack of producer awareness of markets and fresh produce prices;
2. Use of improper technology for harvesting, processing and storage;
3. Lack of product cooling after harvest;
4. Unsuitable transportation of produce;
5. Lack of grading and storage systems;
6. Lack of standards;
7. Lack of packaging;
8. Lack of washing/cleaning systems for fruits and vegetables;
9. Shortage of cold rooms;
10. Lack of awareness of suitable methods of preservation;
11. Lack of suitably integrated fruit and vegetable chains for transportation; storage, sorting, grading, packaging and marketing;
12. Large numbers of intermediaries who create a substantial gap between the farm gate prices of fruits and vegetables and their retail prices to consumers.

Mitigating these problems would necessitate:

1. Education of producers and distributors;
2. Upgrading of facilities for harvesting, transportation, etc.;
3. Upgrading production methods, in order to reduce postharvest losses to an acceptable level;
4. Requiring the use sorting and grading systems in the distribution system;
5. Creating consumer awareness on appropriate methodologies for the household storage of fruits and vegetables;

6. Employment of skilled personnel in the fruit and vegetable processing sector;
7. Improved control of transportation, distribution, storage and processing of fruits and vegetables;
8. Building a suitably integrated fruit and vegetable chain for cooling, transportation, sorting, grading, storage, packaging and marketing of fruits and vegetables in different regions of the country;
9. Support for the development of fruit and vegetable chains in different regions of the country, with emphasis on the use of advanced technologies such as Controlled Atmosphere Storage;
10. Greater emphasis on postharvest research and technology.

Safety is yet another major area of concern. Factors which contribute to safety hazards include:

1. Presence of heavy metals, such as lead and mercury in soil and water used for irrigation or for washing fruits and vegetables;
2. Application of excessive quantities of nitrogen fertilizers to fruit and vegetables in the field;
3. Irrigation of vegetables with sewage or contaminated river water;
4. Improper use of chemicals, such as pesticides and herbicides to control pests, plant diseases and herbs;
5. Use of unpermitted preservatives such as fungicides to fruits and vegetables after harvest;
6. Contamination of fruits and vegetables through the use of manure or compost fertilizer;
7. Production of microbial toxins such as aflatoxins during production, handling, transportation, processing and storage of some fruits and vegetables.

SAFETY ISSUES IN IRAN's FRUIT AND VEGETABLE SECTOR

Heavy Metal Contamination

Industrial development is increasingly causing the contamination of rivers, soil and air with heavy metals such as lead, cadmium and mercury. These chemical contaminants can eventually enter the human food chain, with potential harmful effects on consumer health and safety. Fruits and vegetables are still irrigated or washed in water contaminated with heavy metals or sewage.[8] Javadi *et al.* (1991) reported that the Zayandeh rood (the river in Isfahan, central part of Iran) is contaminated with mercury at levels ranging between 1.0 and 7.2 ppb. Fish caught in this river contain between 0.13 and 0.72 ppb, of that element in their flesh.[8] Water from that river is, however, extensively used for the irrigation of orchards, crops and vegetables as well as for washing these fruit after harvest. Similarly, sewage from Tehran which drains to the Southern part of the city is used for growing vegetables.[8]

Pesticide, Fungicide and Herbicide Residues

Currently, approximately 2.5 million tons of pesticides are used globally. Almost 89% of these pesticides are applied in developed countries. The scope for pesticide application is, however, gradually increasing in developing nations and the incidence of toxicosis is reported to be 13 times higher in developing countries, than in developed countries. According to a WHO report, the incidence of toxicosis increased from half a million cases in 1972 to 1 million in 1985, with 20,000 lives lost, owing to the consumption of pesticides.[9]

Chemical control is more widely applied than biological control in Iran. Nearly 25,000 tons of pesticides are applied on an annual basis in Iran. Systemic pesticides are widely applied for pest control. Methalaxile (Ridomethyle®) is used as fungicide and Thiomethon, which is not permitted, is applied as a general pesticide. Mossaffa (2002) investigated dissociation of these pesticides on cucumbers and indicated that more than two weeks are required for these pesticides to reach a permitted level of 0.5 mg of pesticide per kg of fruit. Unfortunately, some producers sell their produce, prior to this two-week period.[6] Some strawberry producers apply fungicides immediately after harvest in order to protect their produce against mold attack, during distribution. It is, however known, that exposure to pesticides can cause genetic mutations and can have a carcinogenic impact.[8]

Pesticides are indispensable in controlling pest damage and in increasing production yields. One major concern, however, is the need to train farmers in the correct and safe handling of pesticides and in the production of safe produce having lower than maximum residue limits (MRL).[8]

Governments, Organizations and related bodies will play a vital role in achieving this. National food safety programs which harmonize the functions of the research and administrative sectors, extension councils and farmers along with educational programs for the training of farmers in the efficient and safe use of pesticides are required in order to address the issue of chemical hazards.

Microbial and Mycotoxin Contamination

Food borne diseases are caused by the ingestion of contaminated foods. Pathogenic bacteria, protozoa, worms, viruses and natural toxins are the major causes of food borne disease.[9] Symptoms of food borne diseases include diarrhea, nausea, vomiting, dizziness, sore throat and abdominal cramps. An estimated one in three persons in developed countries is affected by food borne diseases. Diarrhea is estimated to be the primary cause of death for children in developing countries.

Fruits and vegetables contaminated by pathogenic microorganisms originating from soil, or from sewage-contaminated water used in irrigation are a major cause of food borne disease. Salad vegetables, which do not undergo a heating process, are also a major cause of food borne diseases.[9]

Bacteria, parasites and viruses are the most significant biological agents responsible for diseases and illnesses in humans. With increasing of use of manure in organic farming, and polluted river water in the production of vegetables, health hazards associated with the consumption of contaminated fruit and vegetables is expected to increase in Iran.[6]

Mycotoxins can pose a safety hazard in fruits and vegetables. Mycotoxins such as aflatoxin and deoxynivalenol are carcinogenic, and may cause chronic and acute diseases in humans. Aflatoxins are produced by *Aspergilus flavus* following the growth of that fungus on grains such as pistachio, peanut, corn. Aflatoxins can survive common food processing treatments, and according to investigations, have been detected in several foods including milk.

Pistachio is ranked third after crude oil and carpets, as an export commodity of Iran. Iran's total production of pistachio was reported at 314,000 tons in 1998. Approximately 135,314 tons of pistachios were exported from Iran in 2002.[2] Aflatoxin contamination is the main problem associated with the export of pistachios to Europe and other countries.

Aflatoxin contamination of pistachios could take place at either pre-harvest or during postharvest handling of the crop. Toxin production at the pre-harvest stage can be controlled by avoiding contact between pistachios and soil during harvest, with the application of proper and timely irrigation, and through proper and timely harvesting. Pest control, biological control and resistant cultivars are also effective pre-harvest measures for the prevention of aflatoxin contamination. Postharvest control of aflatoxins in pistachios can be accomplished by controlling the temperature and relative humidity of the storage environment of the nut. Pistachios must be stored in cold, well aerated stores, and must be rapidly processed and dried.

Pistachio processing facilities in Iran are adequately equipped with processing and drying facilities, and are thus able to control the level of aflatoxin contamination in nuts destined for export. Controls of this type should be applied to all fruit and vegetables.

Nitrite Levels in Fruits and Vegetables

Nitrate and nitrite occur naturally in food. They may also be added to foods through fertilization, or as preservatives. The presence of nitrates and nitrites in foods is of concern given that they can be metabolized to potentially carcinogenic N-nitroso compounds. In light of this, the European Commission's Scientific Committee for Food (SCF) has recommended Acceptable Daily Intakes (ADIs) for nitrate and nitrite. The ADI for the nitrite ion is 3.7 mg/kg body weight and the ADI for nitrates is 0.06 mg/kg body weight. These are equivalent to 219 mg/day (nitrate) and 3.6 mg/day (nitrite) for an adult weighing 60 kg.[8]

Educational programs on the efficient and safe use of fertilizers are required for the farming community.

CONCLUSIONS

The precise levels of losses in fruits and vegetables are not well known in Iran; however according to official statistics, more than 35% of the annual production of fruits and vegetables goes to waste. Reducing postharvest losses in fruits and vegetables in Iran would be less costly than increasing production.

Funding in support of postharvest research and technology is justified, given that post-production and marketing pose the greatest constraints to fruit and vegetable production.

Improper, harvesting, handling, transportation, sorting, storage, marketing and processing practices adversely affect the national supply of fruits and vegetables as well export opportunities for them, with a negative economic impact. Greater emphasis should therefore be placed on postharvest research and technology in order to reduce losses in fruits and vegetables and to enhance quality.

Programs are required for on-farm training of farmers in Good Agricultural Practices and in the safe use of fertilizers, pesticides and herbicides. Farmers should be trained in the use of proper harvesting and handling of produce. Governments should encourage companies and private investigators to develop suitably integrated fruit and vegetable chains for cooling, transportation, sorting, grading, storage, packaging and marketing in different regions of the country. Greater attention should be paid to the local marketing of fruits and vegetables, and Governments should play a role in ensuring safety, storage and marketing of fruits and vegetables.

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11. REPUBLIC OF KOREA (1)

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INTRODUCTION

Cold chain systems preserve the freshness of produce from harvesting through marketing and delivery to the consumer and have had a tremendous impact on the marketing of fresh produce.

For every 10°C temperature change, there is a corresponding two- to four-fold change in the respiratory activities of fresh produce. Therefore, lowering the temperature of fresh produce from 30°C to 0°C in summer can extend the period of marketing by a factor of six to ten, without a reduction in the price.

Table 1. Impact of the Cold Chain System on Fruit and Vegetable Freshness

Parameter Affected	Produce Item	Ambient Conditions	Refrigerated Conditions
Shelf life	Lettuce	3 days at 15°C	35 days at 1°C
Nutrition	Spinach	Vitamin C loss: 85%	Vitamin C loss: 20%
Weight	Cherry	4.4% loss	1.9% loss
Color	Spinach	55% chlorophyll loss	2% chlorophyll loss
Stability during transportation	Strawberry	65% loss during transportation	5% loss during transportation

STATUS OF COLD CHAIN DEVELOPMENT IN KOREA

National refrigeration facilities were installed by the policy units of the Agriculture and Forestry Departments, in support of the Central Union of Agricultural Cooperatives. These facilities consist of 150 seizure ventilated refrigeration units, 150 compulsory ventilated refrigeration units, 4 vacuum ventilated refrigeration units, and 13 water pre-cooling units, which are operated by the Central Union of Agricultural Cooperatives. It is estimated that more than 50 units will be constructed on an annual basis in the future.

Since 1998, government policy has supported the construction of refrigeration systems. Government support is focused on constructing district distribution centers equipped with refrigerated storage units. Refrigerated storage is maintained by the Central Union of Agricultural Cooperatives and self-governing communities. Seizure ventilation refrigeration and water pre cooling systems are constructed by domestic corporations, while vacuum ventilated refrigerated systems are imported.

ECONOMIC EVALUATION OF THE COLD-CHAIN SYSTEM

Economic Significance of Cold-chain Systems

Cold chain systems prolong the freshness of agricultural produce and increase the duration of their marketability. The economic impact of cold-chain systems is due to the following:

- Increased consumer satisfaction due to improved freshness and keeping quality of produce, in keeping with current market trends. Changes in consumer lifestyles increasingly dictate the need for produce which can be stored in the home for extended periods.
- Price stabilization and continuity of supply.
- Reduced total marketing expenses due to reduced losses in farm produce, increased net quantities of fresh produce and reduced unit marketing and garbage disposal costs.
- Improved quality and competitiveness of farm produce, thereby contributing to increased farmer income.

The cold-chain system divides farm produce into two categories: low temperature produce and normal temperature produce. Thus cold chain systems can promote the branding of farm products, thereby enabling the selective purchase of farm products by consumers and contributing to the establishment of competitive marketing of farm produce.

Through backward linkages to the production of cold chain infrastructure (refrigerated transport, cold rooms, low temperature sale stands) the cold chain can contribute to overall national development and improved incomes.

Economic Analysis of Cold-chain Systems

Establishment of a cold-chain system necessitates the establishment of: a postharvest cooling system in the production district, refrigerated transportation and low temperature storage systems. A basic premise in the development of a cold chain system is that the benefits of the system will outweigh the cost. A study was therefore conducted in order to evaluate the economics of cold chain development. For this purpose, a cost-benefit analysis was conducted.

Cost-benefit analyses are generally used for the economic appraisal of businesses, and public projects of the government, and can provide a basis for the design of alternative plans.

Cost of the Cold-chain System

The cost of establishing a cold-chain system can be measured through either an engineering approach, a survey approach or with the use of a production economics model. Given the fact that the cold chain is currently at an early stage of development in Korea, an engineering approach was taken. The engineering approach is based on the knowledge of affiliated experts. It integrates consideration for use of the equipment, and inputs required for use in the cold-chain system (Table 2). The following assumptions were made at the time of low temperature marketing cost measurement, using the engineering methodology:

a. The distribution channel is as follows: harvest → distribution center (pre-cooling, low temperature storage) → refrigerated transportation → distribution center in consumption district (low temperature storage, refrigerated display) → consumer (through a distribution channel).

b. Total expenses were calculated on the basis of the number of cooling facilities and retail outlets required on the basis of the level of domestic production.
   - The number of cooling points needed was equivalent to the mean number of points

required for marketing gross domestic production through a cold-chain system, i.e., when the low temperature marketing ratio is 100%.

- The number of the retail stores required was equivalent to the number of retail stores required for marketing gross domestic production using a cold-chain system, on the basis of the average annual sale of items in the distribution centers of the consumption district.

c. The low temperature marketing cost was determined on the basis of the low temperature marketing ratio(r).

- A low temperature marketing ratio is the ratio of the quantity marketed at low temperature to the gross domestic product for each item.

A net working rate of individual treatments in the cold-chain system can also be interpreted.

Table 2. Basic Conditions Used for Measuring Marketing Cost

Item	Chinese Cabbage	Peach
Production/marketing period (month)	3	3
Domestic yield (MT/year)	384,715	170,044
Cooling (MT/year)	6,480	900
Number of cooling points needed	59	188

The low temperature marketing cost includes cooling cost, refrigeration and transportation cost, and the cost of refrigerated display.

The sum of the low temperature marketing cost ranged from a maximum of 564.6 hundred million won (low temperature marketing ratio 100%) to a minimum of 271 hundred million won a year, in the case of Chinese cabbage, while in the case of peaches it ranged from a minimum of 365.2 hundred million won a year (low temperature marketing ratio 10%) to a maximum 525.3 hundred million won a year (low temperature marketing ratio 100%) (Table 3).

Table 3. Marketing Cost of the Cold-chain System for Chinese Cabbage and Peaches

Item	Chinese cabbage	Peach	
Total cost	271–5,646	3,652–5,253	Ten million won/year
- Distribution center in production district	1,365–2,425	2,244–2,917	
- Transportation	159–1,595	52–529	
- Distribution center in consumption district	1,186–1,626	1,355–1,807	
Marketing cost per unit	147.4–707.0 (100.0–100.0)	309.9–2,154.0 (100.0–100.0)	Won/kg
- Distribution center in production district	63.4–357.1 (43.0–50.5)	172.4–1,326.0 (55.6–61.6)	
- Transportation	41.7 (5.9–28.3)	31.3 (1.5–10.1)	
- Distribution center in consumption district	42.3–308.2 (28.7–43.6)	106.3–796.9 (34.3–37.0)	

* ( ): component ratio (%)

BENEFIT OF THE COLD-CHAIN SYSTEM

The Cold-chain system offers many advantages to consumers. Firstly it greatly reduces price fluctuations in fresh produce, by extending the period of its marketability. Secondly, the net supply of produce is increased, and thirdly, it eliminates the need to sell at giveaway prices since it extends the duration of the marketing period.

At the same time, the cold-chain can have a negative impact on the producer, marketer or supplier. In situations for example where high future farm prices are predicted, the cold chain allows suppliers to predict high revenue through long term stock. Any decrease in price during that period, however, results in a loss of income to the supplier.

For the purpose of this cost/benefit analysis, arbitrage's profit was assumed zero, and was not therefore considered. The benefit of the cold-chain system was evaluated primarily from the perspective of the consumer. An approach of Willingness to Pay (WTP) was used for evaluating consumer benefit. The WTP approach was used to evaluate the value of improved freshness by determining the maximum amount the consumer would be willing to pay for improved freshness.

While the results obtained using this approach are projected values, they can be validated once the cold chain system is fully operational. This methodology however provides an applied principle of welfare economics.

Compensating wage methods, contingent valuation methods (CVM), household production function methods, hedonic price methods can be used as experiential estimate methods of willingness to pay (WTP). The contingent valuation method (CVM) was used for the purpose of this study.

Five hundred housewives, who lived in a city, participated in a survey on low temperature marketing of Chinese cabbage and peaches. The direct question methodology was used for that survey. During the survey, these housewives were asked whether they purchased produce marketed at low temperatures. Housewives who intended to purchase such products were requested to fill in the price directly. The standard of judgment price which was that of produce marketed at normal temperatures was shown to housewives in the process.

Consumer value evaluation for Chinese cabbage was determined using the least-squares method (OLS), while a lin-logit model and a log-logit model were used for peaches. Variables associated with the models were as described in Table 4.

Table 4. Variables in Model

Variables	
B	The price gap between normal temperature and low temperature produce
FRESH	Recognition of freshness
HIS	Corruption experience due to temperature
REC	Recognition of cooling system
AGE	Age
EDU	Education level
INCOME	Household income per year

In the case of Chinese cabbage, the coefficient of freshness and income variables were estimated positive (+), while the age variable, was estimated negative (–). Thus the WTP for Chinese cabbage marketed at low temperature was high in the case of high income consumers who demand freshness. In case of peaches, the coefficients of the price gap between normal temperature marketing and low temperature marketing were estimated negative (–), while for disposal experience and education, variables were, estimated positive (+). It may therefore be deduced that the WTP for the low temperature marketing of peaches is high in the case of highly educated consumers who have in the past had to dispose of these fruit. As regards the price gap variable, the possibility of purchasing peaches marketed at low temperature is low if the price gap between normal temperature marketing and low temperature marketing is high.

Table 5. Estimation Output for Consumer Evaluation Surveys

Variable	Chinese cabbage (LIN-OLS)	Peach (LIN-LOGIT)	Peach (LOG-LOGIT)
INTERCEPT	265.15 (1.205)	–2.3599 (–1.5808)	–4.1332 (–0.70484)
B	-	–0.32694E-3 (–4.1891)	–0.77868 (–4.1612)
FRESH	58.615 (1.818)	-	-
REC	10.828 (0.2908)	0.16392 (1.2243)	0.41217 (1.3077)
HIS	37.457 (0.6879)	1.0052 (3.5607)	1.0076 (3.5615)
AGE	–55.069 (–1.585)	0.32179E-1 (1.0916)	1.4284 (1.2587)
EDU	8.8299 (0.2572)	0.42919 (2.0840)	1.3134 (1.8698)
INCOME	57.838 (3.242)	0.10159E-6 (0.34555)	0.21633 (0.70414)
McFadden R2	0.0936	0.11646	0.12687
Percentage of Right Predictions	-	0.70149	0.69403
N	212	268	268

*( ): t-ratio.

The mean, median, and truncated means could be used as a measurement of consumer benefit achieved through low temperature marketing, in this study. The WTP for low temperature marketing of Chinese cabbage was estimated at 169.3 won/kg, while in the case of peach, it was estimated at 761.3 won/kg (Table 6).

Table 6. WTP in the Cold-chain System for Chinese Cabbage and Peaches

Variable	Chinese cabbage (LIN-OLS)	Peach (LIN-LOGIT)	Peach (LOG-LOGIT)
WTP (won/kg)	169.3	763.4	761.3

An economic evaluation of the cold-chain system introduced for Chinese cabbage and peaches was conducted in order to compare the total cost of low temperature marketing with total consumer benefit. Total consumer benefit was calculated using a representative figure of WTP multiplied by the quantity of low temperature produce marketed. A representative figure of WTP for peaches was determined by truncated mean (log-logit model) to reduce overestimation of WTP.

The low temperature marketing ratio (r) at which total benefit exceeded total expense was 74.3% for Chinese cabbage and 31.3% for peaches (Table 7). In other words, if it is assumed that the cold chain system is established on a national scale, more than 74.3% of Chinese domestic production must be sold by low temperature marketing for economic operation of the chain. This result suggests that the working rate of an individual cold-chain system must exceed the low temperature marketing ratio if it is to be economically operational.

Table 7. Economic Evaluation of the Cold-chain System (Unit: ten million won/year)

Item	Chinese cabbage	Peach
Total cost	271–5,646	3,652–5,253
Total benefit	647–6,472	1,288–12,880
B/C>1	R >74.3%	R >31.3%

DEVELOPMENT SCHEMES

Construction of Low Temperature Marketing Systems in Korea

The introduction of low temperature marketing systems is difficult. In the U.S.A. and Europe, between two and three days are required for the delivery of domestic products from suppliers to consumers. Many farm products are exported in the process. Marketing systems in these developed countries are also well supported by postharvest technologies.

Marketing conditions in the Republic of Korea on the other hand, are somewhat different. The transportation period is less than 5 hours, and farm produce is consumed in the domestic market. Korean produce must therefore be targeted toward either domestic or export markets, and must be further categorized in terms of its storability. Produce destined for domestic consumption does not require an extensive cold chain system. Thus development of the cold chain system in Korea must be tailored to the needs of the country.

Development of Postharvest Technologies

Considerable emphasis has been placed on farm level storage, with little attention paid to cooling technology for fresh fruits and vegetables, in Korea. Other postharvest activities such as cooling, washing, and sterilization, etc., are areas of deficiency in Korea. Postharvest problems cannot be solved with the introduction of advanced technologies. Research and development must be adapted to the domestic marketing conditions in Korea.

Need for Awareness Creation

Greater attention must be paid to raising consumer awareness. The introduction of regulations designed to ensure marketing of quality produce, and to minimize the use of toxic chemicals in farming will not solve the critical problems. A change in awareness will go a long way to improving marketing systems.

12. REPUBLIC OF KOREA (2)

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INTRODUCTION

Safety inspections are carried out to protect the health of consumers. They assure the supply of safe agricultural produce through the systematic management of production, storage, and distribution. The National Agricultural Products Quality Management Service (NAQS) concentrates on the safety inspection of agricultural produce, soil, animal feed, and GMO labeling programs.

SAFETY INSPECTION SYSTEMS

Safety Inspection of Agricultural Produce

Safety inspection is conducted for residues of harmful substances such as pesticides and heavy metals in agricultural produce which is grown, produced, stored, and shipped. In situations where produce is determined to be unsafe, measures are taken by the NAQS to either delay or cancel shipments, or to implement prosecuting producers in order to prevent the distribution of unsafe produce.

Animal Feed Inspection

Animal Feed Inspections aim to produce safe and hygienic livestock products by supplying good-quality livestock. Through quality control, NAQS is undertaking animal feed inspections on 908 animal feed companies nationwide, following the animal feed inspection plan of the Ministry of Agriculture. NAQS has plans for expanding the scope of harmful substances to be examined to include heavy metals, antibiotics, and pesticides.

Labeling of Genetically Modified Organisms

The labeling of genetically modified organisms (GMOs) began in March 2001 in order to provide consumers with information on GMO products. NAQS requires the labeling of soybeans (0.26 million tons) and corn with the exception of animal feed and processed foods from imported soybean (1.39 million tons) and corn (8.16 million tons). More advanced and scientific techniques will be developed by NAQS for the identification of GMOs and to strengthen regulations on the distribution of GMO agricultural produce.

QUALITY CERTIFICATION SYSTEMS

Quality Certification and the Geographical Indication System

The Government has implemented a Quality Certification program to certify the safety of agricultural produce. This program aims to provide consumers with safe food and to produce high-quality agricultural produce.

Geographical Indication Systems aim at actively dealing with international protection trends of geographical indication and at protecting traditional agricultural specialties in domestic and foreign markets.

Environmentally-Friendly Agricultural Product Certification

The Environmentally-Friendly Agricultural Product Certification Program is designed to establish both production and distribution systems for environmentally-friendly agricultural produce and to ensure that all environmentally friendly labeled produce is genuine. Organically produced crops, crops produced without chemicals, or with minute quantities of chemicals, enhance the competitiveness of produce. The program will also contribute to reducing environmental degradation caused by agriculture and to preserving the clean environment.

Certification System for Environmentally-Friendly Agriculture – A Historical Profile

- Quality Certification of organic agricultural produce and crops raised without fertilizer (December 1 1993);
- Quality Certification of agricultural produce produced with little pesticide (March 28 1996);
- Environment-Friendly Agriculture Promotion Law (December 13 1997);
- Quality Certification of processed organic foods (November 6 1998);
- Mandatory Certification of environment-friendly agricultural produce (July 1 2001).

Certified environmentally-friendly agricultural produce is classified into 4 categories as follows:

- *Certified organic* is produced without using most conventional pesticides, fertilizers made with synthetic ingredients or sewage sludge, bioengineering; or ionizing radiation following a three year conversion period;
- *Certified transitional* is produced in a manner similar to that of certified organic, with the exception of the conversion period;
- *Certified non pesticide* is grown without using chemical pesticides and with the controlled use of chemical fertilizers which provide for the use of less than one third of the recommended application dose;
- *Certified low pesticide* is grown using chemical pesticides at less than a half of the pesticide safe application dose and chemical fertilizer at less than half of the recommended dose. Herbicides are not, however, allowed on certified farms.

Figure 1 shows trends in the production of the various categories of environmentally-friendly agricultural produce over the period 2001 to 2004.

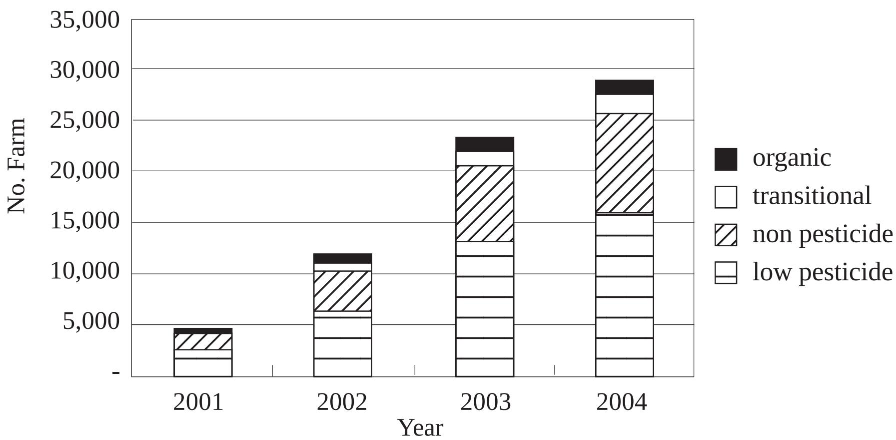

Figure 1. Trends in the Production of Environmentally-Friendly Produce (2001–2004)

Penalty for Consumer Fraud

With rapidly emerging consumer groups, the challenge for the organic sector today is to work with small-scale distributors who are not continuously able to resist temptation to commingle certified commodities with non-certified commodities. Certified farmers themselves violate the EFP Act in noncompliance with national standards. Growth in supermarkets is key to the growth of environment friendly agriculture. Efforts of policy-makers in the organic sector have been focused on the introduction and successful implementation of a new certification system for distributors and handlers.

Quality Certification for Agricultural and Livestock Products

Quality competitiveness of Korean agricultural products is important in meeting the diversified and changing consumer behavior since the launch of the WTO. NAQS will continuously develop and expand the quality certification program to differentiate sophisticated taste and quality of products. At the same time, it keeps monitoring certified produce to prevent the distribution of poor quality produce. NAQS is committed to building agricultural and livestock brand names by tightening inspection on production, by testing products, and by boosting direct marketing through the internet.

Geographical Indication Systems

Geographical Indication systems qualify agricultural produce or a processed product as a local specialty produced in a specific region, in situations where the fame, quality and the other features of the product are derived from a geographical characteristic. The WTO/TRIPS agreement considers Geographical Indication (GI) as an intellectual property and provides for protecting GIs of every member country.

GI-registered products from Korea include: Bosung Green Tea, Hadong Green Tea, Gochang Black Raspberry Wine.

LABELING

Inspection of Labeling of Origin

Labeling of Origin for agricultural produce is designed to protect both producers and consumers and to establish fair distribution on the basis of labels which indicate the origin of agricultural, livestock, and processed products sold in Korea.

The recent liberalization of agricultural markets has led to illegal distribution systems in Korea, with inexpensive foreign agricultural produce falsely labeled as Korean produce. To solve with the problem, NAQS strictly bans the illegal distribution of labels.

Enforcement teams were organized for Origin Labeling in urban areas and have been operating an Early Warning System (EWS) designed to monitor the distribution of 78 vulnerable items including hot pepper powder and beef. In addition, NAQS produced the short informative films introducing the labeling system of origin in order to educate consumer groups. It also employed various promotion tools such as bumper stickers and LED displays.

Honorary inspectors from producer and consumer groups also monitor labeling of agricultural produce. Citizens who report illegal labels or distribution to the authorities (1588–8112) are awarded between 50,000 to 1 million won in cash in order to encourage participation of citizens.

To date, 386 thousands companies involved in processing or sale of agricultural and livestock products were ordered correction of their practices or punished.

Items Affected by the System

442 items of which 176 were imports, 145 were Korean products and 121 were processed goods.

Punishment

Punishment for misguided labels is up to 5 years in prison or up to 50 million won in fine. The punishment for no label: up to 10 million won in fine.

GOOD AGRICULTURAL PRACTICE

Good Agricultural Practices (GAP)

GAP is a system designed to manage factors such as agricultural chemicals, heavy metals, and micro organisms which are harmful to food safety. Quality and safety are ensured by checking produce through the production and distribution cycle.

With growing interest in the safety and quality of agricultural produce globally, GAP is likely to be placed as a trade requirement for the US and Japanese markets.

NAQS has introduced GAP as a requirement in the production of fruits and vegetables for export. The adoption of GAP for vegetable exports commenced in the second half of 2003, and GAP was implemented in fruits in 2004.

In order to establish GAP, a systematic information system which includes traceability was developed, guidelines were prepared and experts were trained.

Projections for GAP Implementation

- 2^{nd} year : decision to introduce GAP system
- 4^{th} year : tentative implementation toward about 350 farms
- 5^{th} year : tentative implementation toward about 950 farms
- 6^{th} year : complete execution

Future Direction

a. Meet international standards such as Codex and EUREP
b. Participation of producer organizations and local governments
   - local government – leading GAP
   - producer organization – inspection and management of GAP
   - NAQS – providing technical assistance, supervision of labeling management organization
c. Application of GAP to imported agricultural produce in the medium or long term after the domestic establishment of GAP production systems
d. Intensive management of districts which lag behind in the safe production of agricultural products

CURRENT STATUS OF THE SAFETY MANAGEMENT OF AGRICULTURAL PRODUCE

- The demand for high quality and safe agricultural produce has grown with the improvement of living standards;
- The poor price competitiveness of domestic agricultural produce with foreign produce has increased the importance of improving the safety of agricultural produce;
- Safety inspection systems have been adopted to stop the production of unsafe agricultural produce at the production stage. The number of inspection cases has increased

progressively over the years. In 1999 there were 29,000 inspection cases; in 2002 there were 56,000, in 2003 there were 59,000 and in 2004 there were 60,000. Shipment of unsafe produce is either cancelled or delayed, and disobedience of such measures results in prosecution.

- Reinforcement of labeling systems to satisfy the right-to-know of consumers.
  - Origin-labeling has been managed by private monitors (consumers) and so-called judicial police officers. Although these are not policemen, they have the same authority as policemen with respect to origin labeling inspections.
    Currently there are 2,800 private monitors and 400 judicial police officers.
  - The implementation of origin labeling showed a progressive growth trend from 1999 through 2003, having been 94.8% in 1999, 95.9% in 2001 and 96.1% in 2003.
- GMO (Genetically Modified Organism) labeling guidance and control has also increased from 87,000 in 2001 to 100,000 spots in 2003.
- Improved awareness of the safety of agricultural produce has resulted in a decrease in the quantities of rejected agricultural produce.
- Volumes of unfit agricultural produce were reported at 1.6% in 1999, 1.23% in 2000, 1.48% in 2003 and 1.3% in 2004.

PROBLEMS ASSOCIATED WITH THE SAFETY MANAGEMENT OF AGRICULTURAL PRODUCE

- Low levels of awareness of producers and an inadequacy of infrastructure for the production of safe agricultural produce. Education programs designed to improve producer awareness are insufficient and measures to reduce chemical use and to implement systematic safety management programs are insufficient.
  - Currently 1,061 pesticides are used in Korea, of which only 9 are biopesticides.
- Overall management systems for harmful materials are insufficient.
- Anxiety about domestic agricultural produce exists owing to limited consumer participation and communication. There is little opportunity for consumers to get access to information and to express their opinions. Educational and publicity programs designed to build consumer confidence in domestic agricultural produce is poor.

MEASURES TO IMPROVE SAFETY MANAGEMENT OF AGRICULTURAL PRODUCE

- Develop infrastructure for safe production
  - Enforce an education system which promotes safety;
  - Increase environment-friendly, low input agriculture;
  - Increase safety-related research and development;
  - Widespread introduction of GAP.
- Reinforce monitoring
  - Develop monitoring infrastructure;
  - Extend the scope of safety inspection;
  - Extend listed pesticides and standards for pesticide residue limits;
  - Extend the participation of local government.
- Reinforce labeling
  - Reinforcement of the control of illegally circulated agricultural products;

  - Reinforcement of public awareness;
  - Introduction of traceability systems;
  - Integration of several labeling and certification systems.
- Increase consumer participation
  - Enforce education and target publicity toward consumers;
  - Extend consumer participation;
  - Build safety portals for agricultural produce and food;
  - Organize advisory committees for the safety of agricultural produce and food.

13. MALAYSIA

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INTRODUCTION

Malaysia's horticultural sector has been identified as a growth sub-sector of agriculture with a projected annual growth rate of 8.4%, against 3.5% for agriculture as a whole. The contribution of agriculture to GDP was expected to increase from 18.7% in 1990 to 21.8% in 2005. In absolute terms, earnings from the agricultural sector increased from 18.7%, valued at USD4,000 million in 1990 to 21.8%, valued at 7,000 million in 2005.

Postharvest handling plays a key role in the development of the fruit and vegetable industry in Malaysia. Postharvest handling integrates a number of operations, including harvesting, grading, packaging, storage, transportation and ripening. Appropriate postharvest handling systems are required to ensure that harvested produce reaches the consumer in an acceptable condition. Fruit and vegetable quality must be maintained throughout the handling chain. Handling requirements, however, vary in accordance with the fresh produce item, the market, consumer, distance and method of transportation.

Produce destined for the export market requires different methods of handling than that intended for the local market. Requirements vary and are determined mainly by the socio-economic background of the targeted consumer. Handling requirements for produce destined for exported to Singapore are similar to those for produce destined for the local market, owing the close proximity of Singapore to Malaysia and the similarity of the market structures of both countries. Produce of much higher quality is generally expected by consumers with higher purchasing power. High quality produce can be obtained through improved postharvest handling.

The development of postharvest handling technologies is carried out by the Ministry of Agriculture through government bodies (MARDI). Research activities focus on improving packaging technologies for the handling of specific fresh produce items. Research activities are also conducted by local universities, although the mission and emphasis of these institutions is slightly different, being focused on the quantitation of losses.

POSTHARVEST HANDLING

Stage of Maturity and Harvesting

Fresh produce must be harvested at the correct stage of maturity, since storage life and eating quality are associated with the stage of maturity at harvest. Harvesting can generally be carried out over a specific range of maturity. Climacteric fruits such as mangoes can be harvested at the mature green stage and can be either naturally or artificially ripened. Non climacteric fruits such as rambutan must, however, be harvested at the ripe stage.

Many local farmers have acquired expertise on the identification of an optimum harvesting stage for the local market, through work experience. This situation is, however, changing gradually.

Harvesting and In-Field Handling

Appropriate methods and tools must be used for harvesting in order to avoid or minimize mechanical injury. Proper container use during harvesting and field handling helps to minimize product losses due the injury or in-field heat accumulation. Warm and injured produce have a relatively short storage life and are susceptible to disease infection.

Packing House Operations

A packing house serves as a venue for the preparation of produce, prior to transportation or marketing. It is often a simple shed equipped with simple equipment. Operations carried out in the packing house are dependent on product and market requirements. Operations for the local market are generally very simple, and include sorting, trimming and packing. Produce destined for export on the other hand, is subjected to more elaborate operations. Common packing house operations for fruits and vegetables are:

- Sorting and trimming
- Washing and fungicide treatment
- Drying
- Grading
- Pre-cooling
- Packing

Proper packing house operations are conducted by FAMA at modern packing house complexes located throughout the country.

Packaging

Fresh fruits and vegetable are packed in suitable containers to provide protection against mechanical and biological damage during transportation. Bamboo baskets are commonly used for the transportation of packaged produce to local markets and to markets in Singapore. Returnable plastic containers have been introduced to farmers and exporters to replace bamboo baskets for field handling, wholesaling and retailing. Corrugated fiberboard cartons are widely used in other countries.

Storage

Fruits and vegetable are highly perishable and can be stored for only a few days under normal tropical ambient conditions. This period of storage is generally sufficient for the delivery and distribution of produce marketed locally or exported by air. A much longer storage life is, however, required for export shipments by sea. Freshness must be maintained during preparation and packing.

Table 1. Storage Requirements of Selected Fruits

Fruit	Temperature (°C)	Relative Humidity (%)	Storage Period (weeks)
Papaya	10	85–90	2–3
Guava	5	85–90	3–4
Pineapple	10	85–90	3
Pomelo	7–9	85–90	12
Carambola:			
B 10	5	85–90	5–9
B 17	5	85–90	6

Source: MARDI

Transportation

Proper handling during transportation is essential if losses are to be minimized and quality maintained. Several studies have been undertaken by MARDI to improve handling and transportation. The use of returnable plastic containers has been well adopted by FAMA for transportation in local markets and to Singapore. Local traders still, however, show a preference for traditional packaging methods such as the use of bamboo baskets owing to their low cost and ease of disposal.

Ripening

Ripening is a final stage in the postharvest handling chain. Ripening can be carried out either by natural means or by induction. For the local market, induced ripening is normally carried out to overcome the uneven ripening of certain types of produce. Calcium carbide is the most commonly used ripening agent in Malaysia. Controlled ripening rooms and ethylene gas are applied to fresh produce for export. Ripening rooms and ethylene gas have been used by FAMA over the past few years.

STANDARDIZATION, QUALITY CONTROL AND QUARANTINE

Much of Malaysia's fruits and vegetable production is destined for the local market. It is, therefore, hardly surprising that fruits and vegetables are of inconsistent quality, and show tremendous variation in size and level of maturity. Inconsistent quality creates many postharvest problems. A number of exporters of fresh produce do not have proper handling facilities, and particularly cold rooms. The quality of produce leaving the country cannot, therefore, be assured. Poor quality produce in export markets can be disastrous to the entire agricultural sector.

In order to develop the local fruit and vegetable industry, standardization and strict quality control must be implemented by Government bodies, and adhered to by the private sector. Currently, more than 48 national standards have been published. These standards have been prepared by technical committees comprising representatives from various government bodies and the private sector. The most significant move was made by FAMA with the implementation of licensing and grading of star fruit for export to the European market.

There is a lack of information and knowledge on quarantine procedures from other countries, and particularly Japan, Australia and the United States. Research on the subject, has already been introduced by MARDI. Under this program, the suitability of several techniques including vapor heat treatment (VHT), dry heat, chemical and cold treatment has been studied.

VHT can be effectively applied to mangoes by exposing the fruits to a temperature of 46°C for 20–30 minutes. In the case of star fruit, exposure of fruits to a temperature of 6°C for 3 weeks is sufficient for insect disinfestation, since 6°C is also the optimum storage temperature for these fruit. Insect disinfestations can also be carried out during transportation. Hopefully, the two methods can be applied in the future to satisfy requirements of importing countries.

ISSUES AND CONSTRAINTS

- Production of unsuitable varieties of fruits and vegetables
- Poor maintenance of farms, since farmers treat fruit and vegetable production as an additional income source only

- Farms are established in locations which are agro climatically unsuitable for fruit and vegetable cultivation.
- Lack of information on quarantine procedures for certain markets, restricts the export of Malaysian fresh produce.
- The produce is not always harvested at the right time (or at maturity) owing to inadequacy of workers.

RECOMMENDATIONS

- The timing of the harvest in often of considerable assistance in reducing insect infestation. In other words, the crops should be harvested as soon as the fruits attain the appropriate stage of maturity;
- Research is required to overcome pest and insect infestation during harvesting;
- Rapid heat build-up occurs in produce, particularly on farms that lack adequate shade. The time between harvesting, grading, packing and transportation from the farm must be shortened;
- Government/private sector should promote good handling practices to officers/farmers/traders, in an effort to minimize postharvest losses;
- The Malaysia Accreditation Farm Scheme (SALM) must be promoted;
- MALAYSIA'S BEST LABELING which is focused on food safety, must be restricted to selected products.

CONCLUSION

Significant progress has been made in the development of postharvest handling technologies for fresh fruits and vegetables in Malaysia. With the availability and use of improved technologies, postharvest losses in fruits and vegetable losses can be minimized and better quality produce can be make available to consumers. Postharvest technologies must be further refined in terms of increasing their effectiveness and reducing their cost. The government and the private sector must implement changes to ensure that all activities of the postharvest handling chain are improved.

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14. NEPAL (1)

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INTRODUCTION

Nepal is a small, mountainous, landlocked country. The Kingdom has a total area of 147,181 sq km. Altitudes vary from 60 m above mean sea level (amsl) to the highest peak of the world, Mount Everest, having an altitude of 8,848 meter (amsl).

Approximately 3 million ha of Nepal's land is cultivated, of which 11.5% is under horticultural crops (MoAC, 2004). Horticultural crops account for 14% of the total value of the agricultural GDP. About 50 species of vegetables, 45 species of fruits and 10 species of spices are cultivated in Nepal (Kaini, 2000).

The country is divided into three physiographic regions, namely: plains (terai) in the south with an elevation of 60–300 amsl; hills in the middle with an elevation of 300–5,000 amsl and mountains in the north with an elevation above 5,000 amsl. Plains, hills and mountains account for 23%, 42% and 35%, of the total area of the country, respectively (Karki, 2002).

Horticultural crops such as mango, banana, pineapple, litchi, guava, tomato, potato, radish, brinjal, okra, chilli, cauliflower, cabbage, cucurbits, taro, coconut, and arecanut are successfully grown on the plains. Mid hills having altitudes of 651 to 1,800 amsl are suitable for the cultivation of citrus, pears, peaches, plums, persimmons, chestnuts, tomatoes, potatoes, beans, sweet peppers, cabbages, cauliflower, radishes, turnips, carrots, leafy vegetable crops, coffee and tea. Similarly, apples, walnuts, almonds, carrots, cauliflower, cabbages, beans and potatoes are the main horticultural crops of the high hills of Nepal.

Production and postharvest technologies differ across the country, and thus postharvest losses in various horticultural crops and production regions are affected accordingly.

POSTHARVEST LOSSES IN FRUITS AND VEGETABLES

Approximately 1,799,973 Mt of vegetable crops are produced on 165,988 ha of land, with a productivity of 10.84 Mt/ha. In the case of potatoes, 1,531,315 Mt of potatoes are produced on 140,171 ha with a productivity of 10.93 Mt /ha. Production areas, levels of production and productivities of different fruit crops are presented in Table 1.

Horticultural produce is highly perishable and is thus highly subject to postharvest losses. Losses in horticultural produce vary between 15 and 35% at different stages along the chain from harvesting to marketing (Kaini, 2000).

According to the Master Plan for Horticulture Development (MPHD, 1991), conservative estimates of losses on a weight basis, were 25% for vegetables, 20% for fruits and 32% for potatoes including tuber seed. The postharvest shelf life of horticultural produce is dependent upon the condition of production, season, variety, the stage of harvesting, the method of harvesting, as well as the packaging, transportation and marketing system.

Table 1. Total Area, Productive Area, Production and Productivity of Fruit Crops in Nepal (2002)

Commodities	Total area (ha)	Productive Area (ha)	Production (Mt)	Productivity (Mt/ha)
Mandarin Orange	14,399.20	7,777	85,696	11.02
Sweet Orange	4,883.50	2,730	31,907	11.69
Lime	3,608.10	2,202	17,127	7.78
Lemon	598.7	473	3,371	7.13
Other Citrus	173.5	129	1,008	7.81
Total Citrus	23,663.0	13,312	139,109	10.45
Apple	7,036.4	3,458	33,050	9.56
Pear	3,485.0	2,739	31,567	11.53
Walnut	2,211.5	1,069	4,139	3.87
Peach	2,384.5	1,962	13,527	6.89
Plum	1,594.2	1,321	9,277	7.02
Apricot	136.0	84	567	6.75
Persimmon	117.4	62	416	6.71
Pomegranate	142.5	94	431	4.59
Almond	15.6	11	11	1.00
Total Deciduous Fruits	17,123.1	10,800.0	92,985.0	8.61
Mango	20,963.6	13,626	127,714	9.37
Banana	4,406.1	3,522	49,972	14.19
Guava	4,343.5	3,158	36,342	11.51
Papaya	2,697.1	2,074	29,231	14.09
Jackfruit	2,169.2	1,479	17,160	11.60
Pineapple	931.8	701	9,980	14.24
Litchi	3,587.6	2,064	15,859	7.68
Arecanut	197.9	109	163.1	1.50
Coconut	343.9	172	349.5	2.03
Total Tropical Fruits	39,640.7	26,905.0	286,770.6	10.66

Source: Statistical Information on Nepalese Agriculture 2002/2003

Table 2. Physical Losses in Horticultural Produce at Different Steps of the Postharvest Handling Chain (%)

Commodities	Loading, unloading and transportation	Storage	Wholesale & retail marketing	Total
Fruits	10–15	-	10–20	20–35
Vegetables	5–10	-	10–20	15–30
Potatoes	5	5–10	5–10	15–20

Source: Kaini, B. R. 2002

Losses During Transportation

According to Bajracharya (2000), the total loss during the transportation of tomato from Syangja (mid hills) to Butwal (markets in the plains) was around 23%. Similarly, the losses sustained during transportation of tomato up to Kathmandu from Kapurkot, Salyan (western hills) and Lal Bandi, Sarlahi (Terai) were approximately 35% (Sharma, 2001/2002).

The MPHD reported a specific case of 35% physical losses in apples transported from Marpha to Pokhara. Werner *et al.* (1991) similarly reported physical losses of 22.85% in tomatoes, 15.84% in cabbage and 12.85% in cauliflower, in addition to the 5 to 10% moisture losses determined by research conducted by FAO, in Terai, Kalimati market and retail shops in Kathmandu.

A study on losses during the transportation of horticultural produce from Bhairahwa, Nepal to Gorakhpur, India conducted by the Marketing Development Division (MDD, 1999/2000), determined a 74% loss in oranges, 26.3% loss in apples, 17.39% loss in cabbages and 15% loss in potatoes. Losses incurred during the transportation of apples, mangoes, cauliflower and cabbages from Birgunj, Nepal to Patna, India were also assessed by the MDD. These were 22.22%, 36.36%, 18.75% and 19.23%, respectively.

Physical losses, which occur during the transportation of tomato, French bean, capsicum and cauliflower from Kapurkot, Shalyan, Nepal to Sitapur market Lucknow, India, were 10%, 5%, 5% and 5%, respectively (MDD). Similarly physical losses in tomatoes, French beans, capsicum and cauliflower from Kapurkot, Salyan, Nepal to Azadpur market, New Delhi, India were 1.33%, 1.25%, 5.88% and 1%, respectively. In the case of transporting cabbage, radish, cauliflower and orange from Birtamod, Nepal to Silguri, India, these were 6.7%, 3.48%, 4.48% and 2.06%, respectively.

Thapa and Shrestha (2001/02) reported that losses in mandarin oranges during transportation from Dhankuta to Kathmandu by bus ranged between 2.7 and 8.2% and thereby recommended the use of small wooden and bamboo boxes of 18"x12"x12" for packaging these fruit. ABTRACO (2003) reported a 50% postharvest loss in mandarin oranges during their export to Tibet and Bangladesh.

Storage Losses

According to the Postharvest Loss Reduction Division (2001/02) the total storage loss of pears kept in cellar stores was 22% over a four week storage period. The fruits were sprayed with 0.1% benomyl prior to harvesting. Paudel *et al.* (2004) verified that the maximum loss in mandarin oranges stored in improved cellar stores was 23% on a weight basis and 15% in number for a 120-day storage period. The MDD (1999/2000) also reported a 10% loss in apples (from Jumla) maintained in cold storage, at Kathmandu.

According to 1999/2000 statistics reported by the MDD, a 10% loss was sustained during the transportation of apples from the farm gate at Jumla to Nepalgunj. Approximately 95% of the apples produced in Jumla are stored in underground pits, while 5% are retained the cellar stores at Jumla. Storage losses using these storage technologies range from 15 to 30%.

The main factors which contribute to postharvest losses in fruits and vegetables include:

- Harvesting of immature fruits and vegetables;
- Faulty harvesting techniques;
- Exposure of the produce to the sun after harvest;
- Rough handling of the produce after harvest;

- Dumping of produce on heaps at collection centers;
- Minimal sorting of damaged produce at selling and collection centers;
- Mishandling during packaging;
- Improper packaging during transportation from collection centers to wholesale markets;
- Use of ordinary trucks and buses for transportation of vegetables and fruits;
- Rough road conditions;
- Rough handling during loading and unloading;
- Use of ordinary rooms for storing the fruits and vegetables at the wholesale and retail markets;
- Display of fruits and vegetables on the open ground at wholesale and retail markets.

RECENT DEVELOPMENTS IN THE MANAGEMENT OF POSTHARVEST LOSSES

The Agricultural Perspective Plan (1995–2015) and the Tenth Five Year Plan (2002–2007) have emphasized the development, dissemination and adoption of postharvest technologies for fruits and vegetables. Efforts have been made to minimize postharvest losses in fruits and vegetables, through the following mechanisms:

- Development of 21 market centers equipped with facilities for postharvest operations in the areas of production;
- Improvement of packaging systems for the transportation of fruits and vegetables from collection centers to wholesale markets. Plastic crates have been introduced to many rural markets for the transportation of fruits and vegetables. Besides efforts have been made to improve the conventional bamboo baskets used for transportation;
- Use of trucks equipped with dividers designed to separate containers in order to facilitate airflow and unloading;
- Installation of well ventilated stores in new rural markets;
- Development of agro processing industries and cold stores to reduce postharvest losses and to add value to fruits and vegetables;
- Provision of a 25% subsidy by His Majesty's Government of Nepal (HMG/N) for the construction of rustic stores and cellar stores in the producing areas;
- Construction of roads designed to connect production areas to market centers, has been prioritized in an effort to commercialize agriculture and to minimize postharvest losses in fruits and vegetables;
- Dissemination of improved postharvest handling technologies in the production centers of some districts;
- Training programs on postharvest operations for fruits and vegetables have been conducted for stakeholders;
- Efforts have been made to improve indigenous postharvest technologies on fruits and vegetables;
- Provision of a 50% subsidy on the electricity costs of cold stores, by HMG/N in an effort to encourage cold storage of fruits and vegetables;
- Provision of low interest and custom subsidies for the construction of cold stores and agro processing industries;
- Provision of subsidies by HMG/N for the transportation and packaging of apple in Karnali zone.

Approaches and Technologies

The importance of applying postharvest technologies to horticultural produce in order to satisfy both national requirements and those of export markets, has been recognized by both the public and private sectors in Nepal. Furthermore, the cost of minimizing postharvest losses in fruits and vegetables is lower than the cost of production. Agriculture Research and Development Centers of HMG/N, non-government organizations (NGOs), international NGOs, and extension agents currently devote considerable attention to the development and dissemination of postharvest technologies for fruits and vegetables. The following organizations are responsible for the development and dissemination of postharvest technologies on fruits and vegetables, to stakeholders:

1. Postharvest Loss Reduction Directorate, Pulchok, Lalitpur
2. Department of Food Technology and Quality Control, Babarmahal, Kathmandu
3. Postharvest Unit Khumaltar, Nepal Agriculture Research Council (NARC), Lalitpur
4. Horticulture Research Division, Khumaltar, NARC, Lalitpur
5. Citrus Research Program, Paripatle, NARC, Dhankuta
6. National Citrus Development Program, Kirtipur, Kathmandu
7. Fruit Development Directorate, Kirtipur, Kathmandu
8. Vegetable Development Directorate, Khumaltar, Lalitpur

Major areas targeted for the reduction of postharvest losses in fresh vegetables include harvesting at the appropriate stages of maturity, harvesting methodologies, trimming, grading and packaging. Plastic crates have been found to be the most satisfactory form of packaging for the transportation of fresh vegetables.

Indigenous technologies are applied in the production of dried and processed vegetables such as *Masaura, Gundruk, Sinki, Chana* etc. Modern food processing technologies for the production of dry and powdered forms of vegetables have also been introduced to satisfy the demand of noodle factories, and for export.

In the case of fruits, major areas targeted for reducing postharvest losses, include harvesting at the appropriate maturity stages for fresh consumption and storage, harvesting methods, grading and packaging. Indigenous technologies are applied in the drying of fruit and in fruit processing to produce products such as *mada*, cider, wine, dry fruits etc. Cellar stores and cold storage technologies have been prioritized for the reducing postharvest losses in mandarins and sweet oranges.

According to Paudel *et al.* (2002), best practices for increasing the shelf life of mandarin orange include:

- The orchard should be visually free from blue mould infection, and the health of mandarin orchard should be maintained;
- Mandarins at 600–1,000 m (amsl) should be harvested for storage during the first week of November;
- Mandarins at 1,200–1,400 m (amsl) should be harvested for storage during the first week of December;
- Mandarins for fresh consumption should be harvested two weeks after those destined for storage;
- Mandarins should be pre-cooling using air, prior to storage;
- Tight and 50% orange colored fruits with small stalks (2 mm) should be selected for storage;
- Fruits should be dipped in 1% garlic extract and shed-dried prior to pre-cooling;

- A relative humidity range of 90 to 95% and temperature range of 8°C–12°C temperature should be maintained in improved cellar stores to achieve a storage shelf life of 100–120 days.

Improved cellar storage has been found appropriate for sweet oranges and apples. Farmers in the remote hills have utilized improved cellar stores for potatoes, cabbages, taro etc. Currently, improved cellar storage is being disseminated to various stakeholders by extension agents. Cold store technology for Nepalese mandarins and sweet oranges developed by Paudel and Chaudhary (2004) is currently being disseminated to stakeholders.

Issues and Problems

Some of the major constraints faced by the postharvest sector in Nepal include:

- Small, scattered, remotely located production pockets with limited access to market centers;
- Lack of sustainable technologies which result in high cost and the use of costly inputs;
- Insufficiently coordinated research and extension systems for the development and dissemination of postharvest technologies for fruits and vegetables;
- Inadequate coordination among various line agencies resulting in week marketing systems due to lack of roads and other development accessories;
- Lack of appropriate technologies for enhancing the shelf life of fruits and vegetables;
- Lack of appropriate postharvest technologies and storage facilities;
- Insufficient marketing facilities and market information on fruits and vegetables;
- Lack of supportive government policies targeted toward increasing the production of value added products from fruits and vegetables;
- Lack of institutional frameworks for the certification of high value commodities;
- Lack of skilled technical personnel in postharvest technology;
- Inadequate attention paid by Government to the development and dissemination of appropriate postharvest technologies of fruits and vegetables.

Measures to Address Postharvest Losses in Fruits and Vegetables

- Development of commercial production centers along with transportation infrastructure;
- Development of sustainable technologies designed to reduce the cost of producing fruits and vegetables;
- Improved coordination between research and extension systems in order to reduce postharvest losses in fruits and vegetables;
- Improved coordination between line agencies for rapid marketing of horticultural produce from production pockets to consumption/market centers;
- Development of appropriate fruit varieties in order to prolong the harvesting season and shelf life. N-162 hybrid cultivars, for example, undergo fewer transportation losses and have a longer shelf-life than other cultivars;
- Development of postharvest technologies including cellar and cold storage facilities for horticultural produce;
- Improvement of marketing information systems;
- Formulation and implementation of favorable government policies to increase the production of value added products from fruits and vegetables;
- Development of institutional frameworks for the certification of high value commodities;
- Development of skilled manpower in the area of postharvest technologies;
- Encouraging the development, dissemination and adoption of postharvest technology for fruits and vegetables.

CASE OF POSTHARVEST MANAGEMENT OF MANDARIN ORANGES IN THE MID-HILLS OF NEPAL

The potential of the mid hills of Nepal lies in the production of high value citrus fruits, off-season vegetable crops, vegetable seed, etc. (APP, 1995). Citrus, in particular mandarin, sweet orange and lime are the important cash crops produced in the region. The mandarin orange is the most important fruit crop produced in the mid hills of Nepal, given the large area under cultivation in that region, and its high commercial value (Subedi *et al*., 1997). The profitability of the mandarin orange depends upon its productivity and market prices. The postharvest glut situation during the harvesting season (mid November to mid January) results in low prices and marketing problems, resulting in considerable losses to farmers. This situation has endangered the entire Citrus enterprise in the country resulting in a negative impact on the livelihoods of mid hill farmers (Paudal *et al.*, 2004).

Poor returns are derived from the majority of citrus orchards, owing to poor management. Thus, despite the immense potential of the citrus industry, its level of growth has been inhibited by the lack of postharvest technology.

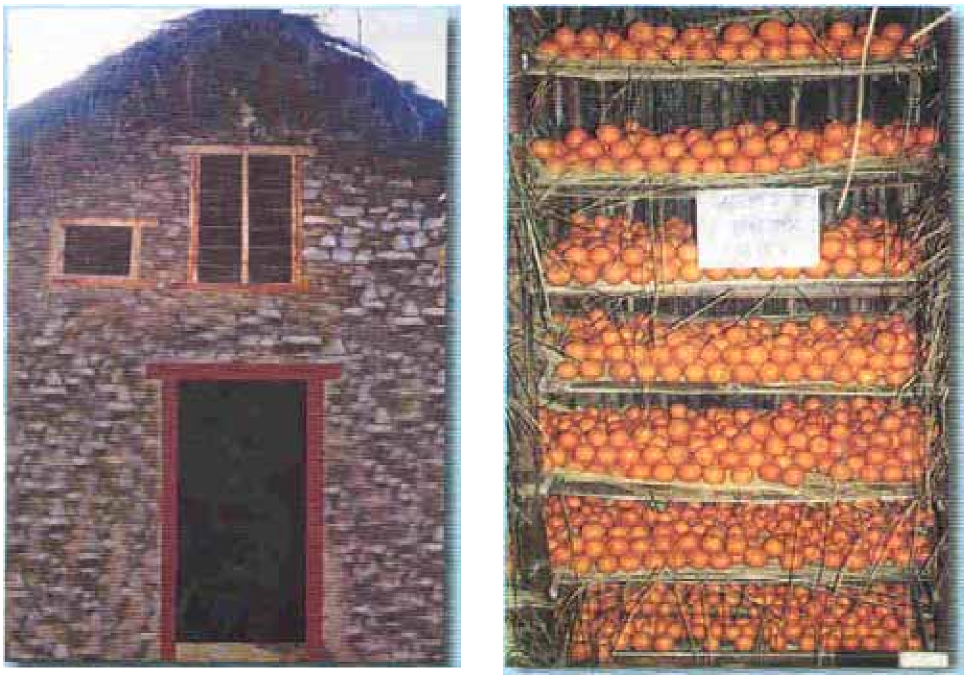
Although cellar storage technology has been disseminated since 1977–78, the full potential of cellar stores is yet to be realized owing to poor design, and construction. The AMARC (AMARC, 2001), categorized cellar stores constructed by the District Agriculture Development Office as a wastage of financial resources, and considered them technically unfit and unsuitable for business purposes.

Cellar stores were upgraded by Paudel *et al.* (2002) to include pre-cooling chambers, and standardized the construction norms. Pre- and post-harvest techniques for increasing the shelf life of mandarin oranges were also disseminated by that group, who trained stakeholders in the construction of improved cellar stores.

The package of practices on pre and postharvest handling of mandarin oranges was developed at the farm level in collaboration with farmers. An appropriate time of harvest was determined for mandarin oranges destined for storage and for fresh consumption. Proper harvesting techniques, fruit collection, grading, and fruit treatments using garlic extractives, pre-cooling and storage techniques were disseminated to the stakeholders.

Box 1
Improved cellar stores for enhancing the shelf life of mandarin oranges

Mr. Narayan Bahadur Karki of Ward No. 2, Muzung, Village Development Committee, Palpa, Nepal constructed improved cellar stores of about 10-ton capacity. He applied proper pre and postharvest techniques to the storage of mandarin oranges. The shelf life of mandarin oranges was extended with negligible losses; 26 fruit out of 500 rotted during a four-month storing period (last week of November to last week of March). The price of mandarin during the harvesting season (November–December) was NPR15/kg, while during the month of March, it increased to NPR34/kg (Karki, 2003). Thus improved cellar store technology was proven to an efficient and economically sustainable method for the storage of mandarin oranges in the mid hills of Nepal.



Improved cellar store (Left) and storage of mandarin oranges on shelves within the store (Right)

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15. NEPAL (2)

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INTRODUCTION

Nepal with three broad ecological zones, the tarai, the mid hills and the high hills, has a climate which favors the production of a wide range of fruits (apple, pear, mandarin orange, mango, banana, etc.) and vegetables (cauliflower, cabbage, turnip, radish, gourds, beans, carrot, okra, brinjal, tomato, etc.). Horticultural crops occupy 11.5% of the total cultivated land (3,091,000 ha) and contribute 14% of the Agricultural Gross Production. Approximately 511,397 MT of fruit are produced on a land area of 54,112 ha and 1,890,100 MT of vegetables are produced on 172,586 ha (MOAC, Krishi Diary, B.S. 2005). Although the country has now commercialized its fruit and vegetable sector, consistency of supply still poses a major constraint.

In the past, fruits and vegetables were marketed by farmers on a small scale in the areas of their production and in near by city markets. The scenario has now changed with the commercial production of fresh fruits and vegetables. Involvement of middlemen /traders/ wholesale/retailers between the grower and the consumer in the marketing chain has initiated the market concept. The importance of postharvest management was realized when products coming to market had to compete with products coming from neighboring countries like India and China. The growing cost of cultivation due to high input costs, the need for hybrid seeds and intensive labor requirements to grow the crop, has forced the grower to think about improving postharvest management practices. Every unit loss in a commodity has made the grower to think about cost of return calculated in terms of money.

The Agriculture Perspective Plan (APP, 1995–2015) on which agricultural development has been framed has prioritized the production of citrus (especially mandarin orange) throughout the mid hills, apples in the high hills and off-season vegetables in hills as well as in tarai. Government policy on the pocket area concept for production further encourages the commercialization of these crops.

POSTHARVEST LOSSES

Postharvest losses have been estimated to be of the order of 20 to 30% for fresh fruits and vegetables and could exceed 50% under adverse conditions. Losses were reported to vary between 20 and 30% for apple, between 15 and 20% for citrus, between 10 and 15% for tomatoes and between 10 and 15% cauliflower (HARP, 2002). Losses in vegetables result from harvesting at an improper stage of maturity, direct packing and shipping without the removal of field heat, improper packaging and insufficient grading and sorting, poor transportation and handling and poor storage facilities. Losses in fruits also result from harvesting at an improper stage of maturity, improper methods of harvesting, packaging, transportation and storage. Fruits are generally harvested by shaking trees or by hitting with a stick. The fruit consequently drop with the peduncle and leaves. The majority of losses occur during transportation from the farm yard to the collection centre and thereafter to the wholesale market and retail outlets.

CURRENT STATUS OF POSTHARVEST MANAGEMENT

Recommended Technologies

Currently available technologies in Nepal are basic and can, therefore, only support domestic requirements. A number of technologies which have been recommended to upgrade postharvest management in Nepal are now described.

Harvesting

Harvesting techniques and maturity indices for apple, orange and banana have been established. Harvesting bags and knives have been developed and distributed to individual farmers on a 25% subsidy. Hand harvesting is also undertaken in specific situations.

Postharvest Handling

Grading and Sorting

Grades have been established for mandarin oranges by the Department of Food Technology and Quality Control. These grades are location specific, being focused on the Gorkha variety, for color and grade specification. The grade sizes range from 68–78 mm extra large, 60–66 mm large, 55–60 mm medium, 50–55 mm small. Grades established by the Post harvest Loss Reduction Division of the Department of Agriculture (DOA) differ somewhat from these standards. Grades established by the Post Harvest Loss Reduction Division are more practical and appropriate for the domestic market. Grading equipment has also been designed and developed on the basis of these grades and is being distributed to collection centres and farmers groups with a 25% subsidy. These items of equipment are designed in accordance with the following specifications:

Large size:	70–75 mm diameter
Medium size:	65–69 mm diameter
Small size:	59–64 mm diameter

Revision of these grades is required in order to harmonize them with the grades of neighboring countries within the WTO context for export.

Packaging

Improvements in the traditionally used packaging such as doko, tokari, and bhanga have been recommended. These improvements provide for cushioning or lining with rice straw, pine leaves, banana leaves and paper at the base and sides to protect from roughness of the packaging.

Doko This is a bamboo made basket used to carry fruits and vegetables on the back, in the hills. It is conical in shape with a slightly narrowed base. It generally has a capacity of 40–50 kg.

Tokari This is a bamboo basket having a capacity of approximately 40 kg, and is used to carry fruits and vegetables on the head in tarai.

Bhanga This is flat basket made of bamboo, to which tokari and jute materials are attached at the top to accommodate a larger volume of produce. It is used in the plains for the packaging of vegetables. It has a capacity of between 100 and 150 kg.

Improved packages include crates, carton boxes, wooden boxes, polyvinyl bags, etc.

Crates These are usually plastic crates which have a capacity 20–25 kg. They are used for tomatoes, cucumbers, capsicum, and gourds (e.g., sponge gourds, bitter gourds, etc.). Crates having a capacity of 20 kg are used for mandarin oranges.

Carton boxes These have a capacity of 20 kg and are used for fruits like apples and mandarin oranges depending upon the compression and bursting effect.

Wooden boxes Being rather costly, these are not generally recommended.

Production pockets are generally located in the hills and in some cases in interior tarai where easy access is not possible. Improved traditional packaging has proven more convenient during transportation by man and mule and less damaging. With time, these packaging materials, however, need to be replaced by even better packaging.

Storage

Rustic stores These are structures having dimensions of 195 cm length x 75 cm width x 225 cm height, which contain five racks with the capacity for the storage of 500 kg of potatoes. These stores are fenced by mesh wire in order to keep out pests and animals. They are covered with straw and grasses. Apples and potatoes can be stored in these structures.

Zero-energy storage structure Fresh vegetables and fruits are stored in zero-energy storage structures. These are constructed using local materials such as brick and sand. The structure is doubled walled with a 4" (10 cm) space between two walls which enclose a central storage space having dimensions of 75 cm x 50 cm x 75 cm. The sand is kept moist by sprinkling water regularly in order to maintain a temperature of 7 to 10ºC. It is covered by a jute matrix which is also kept moist.

Cellar store The cellar store is a warehouse constructed from locally available construction materials such as stone, mud, and sand. The temperature within a cellar is maintained between 4–9ºC, while the humidity is maintained between 75 and 90%. Cellars are used for the storage of apples, mandarins, oranges, and sweet oranges.

MARKETS AND MARKETING SYSTEMS

The Kalimati Wholesale Market is one of the biggest and busiest fruit and vegetable wholesale markets run by the government in Kathmandu proper. Approximately 308 tons of fruits and vegetables enter this market on a daily basis (Proceeding of SAARC workshop 2002). Transactions at this market are valued at 50–60 lakh NRS (USD85,714.29). Fruits and vegetables which originate in different parts of the country are traded at this market. Price control is based on supply and demand. Other markets are therefore both directly and indirectly affected by this market. Fourteen other markets are operational in different parts of the country.

The Kalimati Wholesale Market is supplied with vegetables originating from Kavre, Dhading, Bhaktapur, Kathmandu, Chitwan, Makawanpur, Sarlahi, Bara and Rautahat districts, while its fruits supplies originate from Mustang, Rasuwa, Jumala, Dhading, Tanahu, Gorkha, Ramechhap Syangja, Lumjung, Nawalparasi, Chitwan and Jhapa districts. Fruits and vegetables are also imported from India, China, Bhutan and New Zealand. Farmers and middle-men cannot trade directly at this market. They must either sell their produce to wholesalers or take a fixed commission based on rates from the trader and sell to him. Nepal currently produces the majority of produce sold in that market.

The Kuleshwor Wholesale Market of Kathmandu deals mainly with fruits. Fruits coming to this market originate primarily from India. Between 15 and 20% of the market demand at this market is met by Nepalese produce. Nepalese production is seasonal, while there is a continuous flow of produce from India. Traders in both the Kalimati and Kuleshwor markets sell Indian produce as commission agents and charge a 7 to 10% commission, while Nepalese produce, in general, is sold on the basis of market price. Few farmers are involved in trading produce. Contract farming is not is practiced.

Marketing Channels

1. Indian Grower —> Indian Trader —> Nepalese Trader (commission agents) —> Retailers/cyclist —> Vendors —> Consumer
2. Indian Grower —> India Trader —> Nepalese Trader (wholesaler) —> Retailers/ cyclist Vendors —> Consumers

Conversion Rate of 13 July 2005

1 USD = NRS 70.94

1. Nepalese Produce —> Grower —> Commission Agent/Wholesaler —> Retailer —> Consumer
2. Grower —> Retailer —> Consumer
3. Grower —> Consumer

Eighty percent of the produce marketed in Nepalese markets involves commission agents/wholesalers while only 20% is marketed through grower retailer transactions.

POSTHARVEST PRACTICES

Fruits and vegetables going to market rarely satisfy any specific visual, textural, flavor, compositional, nutritive or safety criteria. Produce is brought to market after harvest with minimal cleaning and trimming of wilted and dried leaves. Vegetables are harvested by hand and are brought to market in traditional packaging such as doko, tokari, bhanga, jute bags and in improved packaging such as crates and polyvinyl bags. Plastic crates are generally used in situations where their return and reuse can be guaranteed.

Currently parameters such as chemical composition, nutritive value and safety are beyond the concept of quality in Nepal. Visual attributes such as freshness size, shape and color are generally the indices used by consumers in the selection of produce. Produce is not graded and is to a limited extent, sorted for the removal of unusable fruits and vegetables. Insect-damaged fruits and vegetables are readily accepted by consumers.

Large quantities of fruits and vegetables are retained on trucks and in some cases are cushioned with paddy straw, moss and banana leaves (in the case of banana transportation). The packages are roughly arranged in ordinary trucks/mini trucks, bus roofs and hand tractors. Traditional packaging does not provide adequate protection given its flexibility; it cannot be properly stacked owing to its height and shape. Many packaging materials were developed for the purpose of either manual haulage or haulage by animals, rather than by transportation. Losses during transportation occur mainly due to bruising and compression caused by the rough inner surface of the package and by overfilling. Further losses are sustained due to mechanical injury of overmature fruits in ordinary transport on rough feeder roads.

Little improvement in transport and packaging systems has been achieved. Currently packaging is lined with cushioning material and trucks have been equipped with racks. Two single layers of packaged produce can generally be accommodated. Farmer or traders now prefer plastic crates for the transportation of vegetables such as tomatoes, bitter gourds, sponge gourds cucumbers, radishes and carrots. They currently demand a government subsidy on jumbo crates having a capacity 50 kg for this purpose.

A wide gap still exists between recommended technologies and their adoption rate. The level of adoption of recommend technologies is still inadequate to support the requirements of external markets. This has been clearly proven through an initiative undertaken by the Agro Enterprise Center, in exporting mandarin oranges, apples and hybrid tomatoes to Bangladesh. Unavailability of required quantities of quality produce, unpreparedness, lack of knowledge of export formalities, of quality standards, harvesting stages, suitability of packaging and grading coupled with the mode of transport including consignment dispatch procedures, led to a loss of 37% in apples within Nepal and 26% during transit to Bangladesh. Hybrid tomatoes were almost rejected owing to the unacceptability of their quality. Similarly a scarcity of quality oranges and conflicts between exporters and importers on the grading of oranges were the main reasons for decreased exports.

Value addition is limited owing to the absence of basic prerequisites such as the availability of raw material, availability of technology, equipment and support services for the establishment and operation of commercially viable processing enterprises. Candies, pickles, banana chips, dried apple chips, cider, and wine are produced at the local level, but have not been commercialized.

ISSUES AND IMPEDIMENTS TO IMPROVING MARKETING AND SAFETY

Proper postharvest management reduces losses and improves the competitiveness of produce in markets. Growers, middlemen, traders, wholesalers, retailers, vendors/shopkeepers, loaders transporter and even consumers have a role to play in ensuring produce quality. Improved quality has implications for improved prices for growers/traders/wholesaler/retailers and quality produce for consumers. These principles are not, however, understood by stakeholders at large. Proper postharvest specific infrastructure and appropriately located markets are equally important requirements. A number of factors currently adversely impact upon the dissemination of postharvest practices, and the availability of postharvest infrastructural facilities which are appropriate for maintaining quality. These factors are described below:

- Inadequate technology to support competitiveness;
- Small landholdings and landholdings under different ownership constrain the consistency of produce supplies. Farmer organizations and farmer co-operatives therefore need to be strengthened and their production planning capacity improved;
- Greater attention must be given to input quality. Varieties selected for cultivation must not only produce good yields, but must resist pest and pathogen infestation and must be suited to the target market;
- Pesticides and fertilizers must be judiciously applied and appropriately recorded to assure the safety of produce. Facilities for the testing of residues must also be made available;
- Inadequacy of postharvest specific infrastructure such packing houses, pre-cooling and sorting facilities, results in improper sorting and storage of produce;
- Lack of auxiliary industries for the production of packaging materials, tools and equipment;
- Poor networking of the marketing systems which results in a considerable share of the profit (more than 50%) going to middlemen. The situation must be improved so as to allow a larger share to go to the grower;
- Lack of a crop insurance system;
- Poor understanding of farmers as to their roles, responsibilities and commitment to the export trade of fruits and vegetables;

- Lack of enforcement of quality standards for national markets and harmonization of quality standards with international markets. Plant quarantine obligations and safety issues to support WTO requirements should be considered seriously;
- Deterioration of produce quality owing to rough handling during postharvest operations, improper packaging and damage during transportation. Drivers will often take the maximum load possible in order to save on taxes and transport costs;
- Government policy regarding fruit and vegetable production. The Government has prioritized fruit and vegetable production in the hills which necessitates that they be transported either by mule or by man/porter to access roads for unloading and re-packaging, which leads to quality deterioration and losses.

REQUIREMENTS FOR IMPROVED ADOPTION OF BEST PRACTICES

Nepal, being at an early stage in the commercialization of fruits and vegetables, has only recently realized the importance of postharvest management practices. The need for proper postharvest management, for the adoption of standards and for the selection of appropriate varieties, to assure the competitiveness of fruits and vegetables has, however, been realized in the country. Improved adoption of postharvest practices would, therefore necessitate the following:

- Awareness creation among farmers, middle men, traders, wholesalers and even consumers about postharvest losses and quality. This can be accomplished through mass media such as radio television, posters, video pamphlets and through extension;
- Physical facilities for the development of simple affordable technologies for adoption by growers, in order to enhance quality output;
- Availability of tools and equipment at prices which are affordable to growers and traders;
- Availability of reasonably priced packaging and package materials on the local market;
- Exploration of the potential for adapting traditional packaging to allow for improved cushioning and stacking. Traditional packaging has been adopted in light of its suitability under local conditions. Mass production of these packaging materials would facilitate their availability and provide job opportunities for many;
- Conduct of stakeholder workshops to improve their capacity in postharvest management;
- Development of skills to support postharvest development. Within this context, expertise must be developed in marketing, postharvest management, engineering and extension;
- Establishment of laboratory facilities for monitoring quality and safety attributes of fresh produce;
- Development of appropriate, cost effective storage facilities which make use of local resources;
- Technical services must be provided and stakeholders must be educated on pre- and post-harvest management and its impact on produce quality;
- Governmental and semi-governmental organizations working on technology generation should maintain good linkages with INGOS and NGOS involved in technology dissemination. Although the Government has its institutional networking up to the grass root level (service centers) within districts, it is still unable to provide sufficient services to target groups. There is, therefore, a need for collaboration with INGOS and NGOS for extensive dissemination of technologies among the target group for adoption;
- Direct training of farmers in postharvest management at production sites in an effort to develop a cadre of trainers who can in turn train other farmers with a multiplier effect.

SUCCESS STORIES OF POSTHARVEST MANAGEMENT PRACTICES ADOPTED BY FARMERS

A few postharvest technologies which improve the safety and quality of fruits and vegetables are currently applied in Nepal. These technologies include the use of the cellar store, zero energy storage structures and crates for the transportation of fruits and vegetables. Smoke is used for the ripening of bananas and papayas.

Cellar Stores

Fruits and vegetables are generally sold in the fresh form during the season of production, owing to the shortage of storage facilities. Cold storage facilities are used primarily for the limited storage of seed potatoes. Simple low cost, natural conditioned on-farm storage structures are, however, used in Nepal for the storage of fruits (mandarin, apple and sweet orange) and vegetables without much spoilage. Use of these structures in the high hills for the storage of apples and citrus (mandarin and sweet orange) and in the mid hills has been promoted by the government, the Department of Agriculture and by the semi government through the provision of a 25% subsidy.

Studies have shown that mandarin oranges can be safely stored in cellar store for more than 100 days with losses ranging between 9 and 17%. Between 30 and 35 cellar stores having a capacity of between 4 and 5 tons have been operational in Mustang for the storage of apples (personnel communication). Among the various small scale storage structures which include rustic stores, sand pits, normal storage and zero energy chambers, cellars are the most popularly used by farmers (HARP, 2002). Mandarins can be stored for 120 days with storage loss of 11% without any significant deterioration of quality (LARC, 1998). Similarly mandarin oranges in cellar stores can be stored for 60 to 90 days at 8–10°C and 90% relative humidity with a 20–25% loss. Mandarin oranges must be pre cooled and transferred to the store before sunrise (DOA, 2004). Fruits in cellar stores should be stored either in racks or in plastic crates in less than 4 layers.

Construction of Stores Cellar stores, having a capacity of between 2 and 5 tons, are constructed in hillock-like places in which three sides of the structure are enclosed by hills and one north facing side is dug into a cave-like structure with an entrance. Cellars are generally 3m x 3m x 3m in size. Outer walls of the cellar are constructed to a thickness of 30 cm, in either brick or stone. An inner wall of the same thickness is erected and the space between the two walls is filled with sand up to a height of 2 m. A perforated polythene pipe (2.5–5.0 cm diameter) is laid at the surface of the sand. The inner end of this pipe is closed, while the other end is attached to a tap water source in order to maintain the relative humidity. A wooden lockable door, having dimensions of 1 m x 2 m is installed in the front open space of the structure. At the bottom of the door, a space of about 30 cm x 100 cm covered with wire mesh, is maintained to allow for the circulation of fresh cool air within the cellar. Two ventilators (50 cm x 30 cm) lined with fine mesh (one at the front and the other at the top of the rear wall opposite to the door) facilitate the removal of hot air. The roof of the structure is covered either with planks or with bamboo which is arranged horizontally. Corrugated galvanized sheets are layered over the planks or bamboo roof. These sheets are further covered with a layer of either earth or mud 30–60 cm in thickness, in order to ensure protection from direct sunlight. Proper drainage is maintained.

Zero Energy Storage Structures

Zero energy storage structures are generally employed by small farmers with small landholdings, for the storage of fresh fruits and vegetables over a two to three week period. As the name suggests, these structures do not require any energy for operation. Their operation is based on the principle of evaporative cooling whereby the temperature is decreased and the relative humidity increased, creating an environment suited to maintaining the freshness of fruits and vegetables.

The structure is constructed using brick and sand. It is almost rectangular in shape, having storage dimensions of 75 cm x 50 cm x 75 cm. Its outer and inner walls are separated by a 10 cm space, filled with sand. The sand is frequently watered in order to maintain a temperature of 7–10°C. The structure is covered by a bamboo frame which is overlayed by a jute matrix is kept which is constantly moistened by sprinkling with water. The jute matrix can be further covered in order to protect it from exposure to excessive sun or rain.

Storage studies have shown that carrots can be stored in a zero energy storage structure with a 5.87% loss for up to three weeks, and with a 14.8% loss for up to four weeks. Tomatoes at different levels of maturity also show differences in their storage stability in these structures. A fourteen percent loss was observed for ¼ red tomatoes stored in a zero energy chamber after two weeks of storage, while an 18.1% loss was observed for ¾ red tomatoes and a 25.2% loss was observed for fully red/ripe tomatoes for that period. According to Acharya (2001), tomatoes can be stored for a period of up to 20 days at 16°C and 89% relative humidity (Acharya, 2001). Mushrooms can be stored in zero energy stores for 2–3 days (NARC, 1997) while oranges can be stored for up to 22 days at an average temperature 10.5°C and 90% relative humidity. Freshly harvested vegetables such as radishes, cabbage and capsicum leafy vegetables can also be stored in such structures.

Zero energy storage structures have been promoted in Nepal by both government and non government organizations. The Department of Agriculture also provides subsidies on such structures and on the costs of locally produced materials.

Crates

The use of plastic crates having a capacity of 20–25 kg for the packaging of fresh fruits and vegetables is growing in popularity among middlemen and traders. Use of these crates has resulted in significant reduction in transportation losses. Plastic crates were introduced into the marketing system through the Government (DOA) and are still being subsidized by it. Their popularity is slowly growing among farmers and traders, particularly in situations where their return and reuse can be guaranteed. The use of cushion-lined crates for transporting produce is growing in popularity, owing to increasing cost of carton boxes which are not reusable.

Smoking of Bananas and Papayas

A smoking process is used in order to facilitate the ripening of bananas and papayas. This process which takes place over a 24 hour period involves burning husk and wood in a drum, within a closed room. The number of drums used varies in accordance with the size of the room and stage of maturity of the fruit. After smoking the fruit are removed, following which they are sold to retailers.

The use of smoking has been encouraged as an alternative to carbide treatment of fruits. Traders, particularly in Kuleshwor market of Kathmandu, have been engaged in the use of this process.

CONCLUSION

Nepal has the potential to produce a variety of fruits and vegetables for international market. Limited levels of production, small land holdings, poor postharvest management, poor physical facilities, and inadequate modern technologies and skills, pose major constraints to the fruit production sector. There is the need for strategic planning by the Government to assure that produce conforms to market requirements. In this regards, awareness must be created among consumers, growers, traders, middlemen wholesalers and the general public. Competitive cultivars and quality standards must be met by exporters. Trade must also be encouraged. Market information is essential for the decision making process.

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16. PAKISTAN

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INTRODUCTION

Pakistan has a geographical area of about 79.61 million hectares, of which 22.04 million hectares (27.68%) is under cultivation. Approximately 82% of the total cultivated area is irrigated mainly by canals and tube-wells. Pakistan's population in mid-2004 was estimated 148.72 million.

Although Pakistan's economy has undergone considerable diversification over the years, agriculture sector still contributes 23.3% of the national GDP, accounts for 42.1% of the total employed labor force, and is the largest source of foreign exchange earnings.

Horticulture sub-sector contributes substantially to the agricultural GDP of the country. Fruit and vegetable production in Pakistan in the year 2003–2004 is summarized in Table 1 and Table 2.

Table 1. Vegetable Production in Pakistan (2003–2004)

Commodity	Quantity in 000 tons
Potato	1,938.1
Onion	1,449.0
Tomato	412.8
Excluding Potato	3,028.4

Table 2. Major Fruits Produced in Pakistan (2003–2004)

Commodity	Quantity in 000 tons
Citrus	1,760.3
Mango	1,055.9
Banana	174.7
Apple	333.8
Guava	549.6
Apricot	210.9
Peach	76.2
Plums	64.2
Grapes	50.8
Pomegranate	55.6
Dates	426.8
All Fruits	5,712.4

Pakistan has a comparative advantage in the production and export of high value and non-traditional crops. Despite this comparative advantage, returns to farmers are low. Farmer income is greatly affected by postharvest losses, which average between 30 and 40%. The Government of Pakistan relatively recently launched an "Agribusiness Development and Diversification Project" with the assistance of the Asian Development Bank. The main objective of the project is to achieve self-reliance in agricultural commodities, ensure food security and improve productivity of crops and livestock. This project places special emphasis on market-oriented demand-based production systems which will lead to increased production and productivity within the sector, the ultimate goal being to increase farmer income and decrease rural poverty. The project will focus on high value cash and horticultural crops and livestock development.

FRUIT AND VEGETABLE EXPORTS

Production, consumption and trade in fresh fruits and vegetables showed an increasing trend, globally. Pakistan, which exports a mere 3.35% of its fruit and vegetable production, is currently ranked 44th globally, for trade in these commodities. Pakistan's export trade in fruits and vegetables can easily be either doubled or trebled. Pakistan currently produces a diversity of fruits and vegetables. Much of this produce, however, goes to waste owing to improper postharvest handling.

Pakistani fruits and vegetables are in global demand. Pakistan currently exports fruits and vegetables to Europe, the Middle East, the Far East, India and Sri Lanka. Mangoes, kinows, apples, dates, peanuts, oranges and guavas are main fruit exports (Table 3), while potatoes, onions, garlic, mushrooms and chillies are the major vegetable exports. Pakistan is, however, heavily reliant on one single market for each fresh produce item exported. Dubai is, for example, the largest market for Pakistani mangoes, followed by the United Kingdom and Saudi Arabia. Sri Lanka is the only market for Pakistani apples.

Table 3. Major Fruit and Vegetable Exports from Pakistan (1999–2001)

Commodities	July–June Qty.	1999–2000 Value*	July–June Qty.	2000–2001 Value*
Fruits & Vegetables	474,013	122,497	415,258	104,086
I. Fruits	239,823	79,892	260,054	78,705
a) Kinnow	82,750	13,916	97,028	16,310
b) Apples	4,021	1,280	1,475	454
c) Mango	47,602	11,576	53,444	17,005
d) Dates Fresh	6,672	3,330	6,622	2,481
e) Dates Dried	57,545	20,655	73,334	23,499
f) Fresh Fruits NS	28,515	7,894	18,870	5,985
g) Pine Nuts	2,984	17,286	1,774	8,151
h) Oranges	2,107	422	1,031	186
i) Other fruits	7,627	3,533	6,476	4,634
II. Vegetables	228,171	38,149	149,227	22,290
Excel Dried leguminous				
a) Potatoes	91,059	9,727	58,450	6,656
b) Onion	128,672	19,885	77,168	10,280
c) Other Fresh Vegetables N.S.	5,320	1,132	8,476	1,976
d) Mushroom	97	6,898	23	2,136
e) Garlic	743	325	359	177
f) Other Vegetable	2,280	682	4,751	1,065
III. Fruits & Vegetable Juices	6,018	3,956	5,751	3,090

* (Thousand dollars) *Source*: Export Promotion Bureau Government of Pakistan

STATUS OF POSTHARVEST LOSSES

During peak harvest periods there is an abundance of fruits and vegetables in the growing areas. Fruits, being perishable in nature cannot be stored in the fresh form over extended periods, and consequently vary tremendously in price, with lowest prices obtained during seasons of peak production. Postharvest handling, grading, packing, transportation and storage techniques/facilities are inadequate and with the exception of apricot dehydration, relatively limited processing is carried out. Levels of postharvest losses in fruits owing to improper harvesting, handling, grading, packing, transportation and storage are summarized in Table 4.

Table 4. Postharvest Losses in Fruits Produced in the Northern Areas of Pakistan

	Fruits	Production (000 Kg)	Wastage (000 Kg)	Losses (%)
1.	Almond	1,983	121	6.10
2.	Apple	15,449	4,169	26.99
3.	Apricot	107,737	48,626	45.13
4.	Cherry	1,862	1,165	62.57
5.	Grapes	7,178	1,510	21.04
6.	Mulberry	16,556	8,398	50.72
7.	Peaches	4,447	1,346	30.27
8.	Pear	4,128	633	15.33
9.	Plum	710	243	34.23
10.	Pomegranate	2,221	692	31.16
11.	Walnut	6,552	439	6.70
12.	Other Fruits	617	160	25.93

Source: Study on Crop Production and Marketing in Northern Areas Development of Agriculture, Northern Areas

Postharvest Losses in Apples

Causes of Postharvest Losses in Apples

1. Lack of knowledge about maturity indices
2. Improper harvesting procedures
3. Lack of grading and sorting systems
4. Lack of postharvest treatment
5. Inadequate packing material and procedures
6. Inadequate transportation systems

Basic Requirements for Proper Postharvest Management

The following are areas in which there is a requirement for information dissemination and capacity building:

1. Maturity indices for apple varieties developed by the Horticultural Research Institute, Faisalabad, must be disseminated;
2. Proper harvesting with the use of clippers;
3. Cleaning and washing of fruits;
4. Sorting and grading standards;
5. Packaging for domestic and export markets;

6. Storage management;
7. Practical demonstration of storage techniques;
8. Preparation of value added products such as jellies etc. at the domestic and commercial levels;
9. Study tours at the field and factory level.

Successful postharvest handling of fruits and vegetables necessitates careful coordination and integration of various steps from harvest to the consumer, if product quality is to be maintained. Horticultural quality refers to those characteristics which the consumer associates with each commodity. It is important to keep in mind that quality loss to fresh fruits and vegetables is cumulative. Each incident of mishandling along the chain reduces final quality at the consumer level.

There is need for the development of infrastructure to promote the export of Pakistani fruits and vegetables. Improved facilities will enhance returns to farmers. Management of fruit and vegetable supply chains is also critical Major stakeholders in such chains include growers, infrastructure providers and exporters.

Supply chain management must consider the following, with respect to the export of fresh fruits and vegetables:

Post-Production Losses

Statistics compiled by Pakistan's Ministry of Food, Agriculture and Livestock, indicate that improper postharvest handling results in the loss of approximately one third of the yields of fruits and vegetables produced in Pakistan.

Perishability

Fresh fruits and vegetables are highly perishable and cannot be stored for extended periods unless they are harvested, properly handled and maintained in a controlled temperature environment (cold storage).

Quality

Produce quality is a relative term and is considered as combination of agronomic practices, variety characteristics and other grading, packing and processing standards. The absence of single factor can reduce the quality and acceptability of fresh produce in international markets.

Packhouses are important in this regard and require proper attention from Governments as well as from the private sector. There is a need to develop packhouses in the vicinity of international Airports and Seaports. These packhouses should be supervised by the private sector, and overseen by the Government. Collaboration between the government and the private sector is required for success in fresh fruit and vegetable handling.

FOOD LAWS/ACTS IMPLEMENTED IN PAKISTAN

In order to safeguard the interest of the consumers the following Act/Laws on Food Safety have been enforced in Pakistan:
1. Pakistan Animal Quarantine Act
2. Pakistan Plant Quarantine Act
3. Pakistan Fish Inspection and Quality Control Act
4. Federal Seed Certification
5. Food Grain Testing

6. Pakistan Standards and Quality Control Authority Act
7. Pakistan Pure Food Laws
8. Pakistan Agricultural Research Council Act
9. Agricultural Produce (grading and Marketing) Act

For the enforcement of above Acts the Government has established specialized Departments to undertake the work of Plant and Animal Quarantine and Food Safety, Quality Control and Certification measures. The objectives and responsibilities of some related organizations/departments are summarized below:

Plant Quarantine

The Department of Plant Protection has a mandate to perform protection and quarantine activity under the Pakistan Quarantine Act. This Department has been authorized the function of locust survey and control, pest control and pesticide registration under the Agricultural Pesticide Ordinance 1971 and the Agricultural Pesticide Amendment Act of 1997. The Department plays a vital role in maintaining quality control and has established a pesticide testing laboratory. It is responsible for the analysis of registered samples of pesticides imported into the country. The department provides inspection services at entry points to check for disease, pest and infestation of plant and plant materials. It issues Phytosanitary Certificates and Import Release Orders in respect of all plants and plant materials imported and exported. The Pakistan Plant Quarantine Act has recently been reviewed an updated to meet the requirements of SPS agreements on Agriculture.

Seed Certification and Registration

The Federal Seed Certification and Registration Department is responsible for seed testing and seed certification. Through the provision of the Seed Act 1976, this Department is responsible for controlling and certifying the quality of seeds, for carrying out the inspection of crops of registered varieties and for their release for sale. It is also responsible for drawing random samples and conducting laboratory analyses to ascertain their purity, viability, germination capacity and health status. It issues certificates in respect of seeds, which meet the prescribed standards of quality.

Food Standards and Quality Control

Under the Pakistan Standards and Quality Control Authority Act standards have been developed for semi processed and processed food items and manufactured items. Standards are either compulsory or may be adopted on a voluntary basis. Of about 15,000 standards, only 46 are mandatory. Mandatory standards have been developed for edible oil, banaspati ghee, bottled drinking water, carbonated beverages and biscuits.

Pure Food Laws

The Pure Food Ordinance of 1965 and Pure Food Rules of 1965 have been enforced in Pakistan to assure Food Safety. Provincial Governments and Municipal Corporations are authorized to implement these Laws through public analysts who are responsible for ascertaining whether or not food is fit for human consumption. Random samples are collected and tested for their compliance with standards. The law provides for:

i) Prohibition of the mixing and sale of mixed foods;
ii) Prohibition of the sale, preparation, manufacturing, import or export of unwholesome food for human consumption;
iii) Prohibition of sale or manufacture of food which is adulterated or not of the nature, substance or quality demanded;

iv) Appointment of local authorities to enforce Ordinance;
v) Registration of manufacturer and wholesale business;
vi) License for manufacturers, shortage and sale of goods;
vii) Sampling methodologies and certificates of analysis; and
viii) Penalty and imprisonment for offence.

Federal Agricultural and Livestock Products Marking and Grading Department

The Government has adopted an Act namely; Agricultural Produce (Grading and Marking) Act, under which grades and standards of quality of agricultural and livestock commodities are laid down and enforced for export. This Act aims to regulate the export of uniform quality produce. The Federal Agricultural and Livestock Products Marketing and Grading Department administers to this Act. Facilities for inspection and certification are provided at all major export points. This Department is inter-alia responsible for conducting research on Agricultural Commodities and for providing market intelligence services. Comprehensive market and laboratory research is undertaken to formulate grades and quality standards for agricultural and livestock commodities. It also provides market intelligence services to all stakeholders through the publication of market reports and price bulletins. The Department has so far established standards for 41 items of agricultural and livestock origin. The Agricultural Commodities include citrus fruits, lime and lemon, chilies (whole), turmeric (whole), ginger (whole), garlic, onion, potato, radish, eggplant, peas, asparagus, Brussels, sprouts, cauliflower, tomato, turnip, cucumber, green chillies (large), lady fingers, arum, guava, molasses, dates, banana, mango, oil cakes, including solvent extracted meals.

Strengthening of Laboratory Facilities

Various analytical laboratories involved in the testing of agricultural commodities including food items and horticultural products are being updated with new and modern testing equipment. For example:

- A Residue testing laboratory has been set-up in the Department of Plant Protection;
- A VHT plant has been set up to treat export consignments of fruits and vegetables to ensure fruit-fly free produce;
- The laboratory of the Test House, Agricultural and Livestock Products Marketing and Grading Department is being updated with modern equipment for the conduct of physical, chemical and microbiological analyses of agricultural and livestock commodities destined for exports;
- Laboratory facilities of Pakistan's Standards and Quality Control Authority have been updated.

Promotion of Food Safety Measures

The Government has taken some important decisions to promote food safety in Pakistan. In March 2003 Pakistan hosted a SAARC countries workshop on the establishment of a Regional Network on Sanitary and Phyto-Sanitary Measures and Quality Control Systems. The following broad-based decisions were arrived at in the workshop.

(i) Updating of existing legislation;
(ii) Harmonization of rules, regulation and laws;
(iii) Regional capacity building measures;
(iv) Strengthening of inspection, testing certification systems and mutual recognition of laboratory services;
(v) Strengthening of food laboratories and testing facilities;

(vi) Early warning systems;
(vii) Legislation of Food Quality Control Laws at the federal level for quality testing and for the certification of food items for import and export purposes;
(viii) Quality control and inspection agencies in the public sector have reviewed the existing Laws/Acts and have proposed amendments necessary to bring these Acts/Laws in conformity with WTO requirements and international standards;
(ix) A Technical co-operation Projects (TCP) between the Government of Pakistan and UN Food and Agricultural Organization (FAO), under which FAO will provide USD390,000 for control of Avian Influenza in the country;
(x) Updating of National Guidelines for the prevention and Control of Avian Influenza.

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17. PHILIPPINES (1)

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INTRODUCTION

The agricultural sector in the Philippines provides a source of income to many small farmers. It is also a source of fresh produce and processed products for the global market. The fruit sector plays a key role in Philippine agriculture and makes a substantial contribution to food security, human nutrition and income generation. Bananas and breadfruit are good supplements or substitutes for staples such as rice and corn, during periods when production of these staples is low. Fruits are considered essential constituents of the Philippine diet. The processing of fruits into value-added products such as dried fruits, purees/concentrates, jams and fruit powders, provides a source of income and employment for many in the Philippines.

The favorable climate and fertile soils of the Philippines make it an ideal location for tropical fruit production. Although more than 300 indigenous and exotic edible fruit-bearing species are reported to exist in the country, only 20 species are grown commercially and are considered to be of economic importance (Table 1). Bananas, mangoes, pineapples, papayas and citrus (*calamansi*) are the leading export winners. Republic of China, Republic of Korea, Japan, Singapore, Hong Kong, and People's Republic of China were the major export markets for these crops.

Table 1. Area and Production of Ten Important Fruits in the Philippines in 2000 (BAS, 2001)

Commodity	Area (ha)	Relative area under cultivation (%) [1]	Production (Mt)	Proportion of total fruit production (%)[2]
1. Banana	382,491	61.66	4,929,570	63.11
2. Mango	133,815	21.57	848,328	10.86
3. Pineapple	42,968	6.93	1,559,563	19.97
4. Citrus (Calamansi & pummelo)	24,066	3.88	227,169	2.91
5. Jackfruit	11,999	1.93	51,163	0.65
6. Papaya (all varieties)	8,440	1.36	121,304	1.55
7. Durian	7,010	1.13	25,764	0.33
8. Avocado	5,124	0.83	38,086	0.49
9. Sugar apple	3,041	0.49	5,340	0.07
10. Mangosteen	1,354	0.22	4,692	0.06

[1] Area relative to the total area under fruit crop cultivation (620,308 ha)
[2] Volume relative to total volume of fruit production (7,810,979 Mt)

Among the commercially grown fruit crops, bananas ranked first, while citrus ranked fourth in terms of area and volume of production. Pineapples ranked second to bananas in terms of volume but ranked third only to mangoes in terms of production area. Papaya production was much lower in terms of cultivated area, but ranked fifth in terms of volume of production. These crops contributed 18% to the gross value added (GVA) in agriculture valued at PHP 182.38 B, with banana contributing 40%, mango 38%, pineapple 21%, and calamansi 1%.

Bananas and pineapples are also produced by multinationals on commercial farms in the southern island of the country (Mindanao) while mangoes are produced on small farms or as a backyard crop of households throughout the country. Two citrus varieties, namely pummelo and the indigenous calamansi are of economic importance. As in the case of mangoes, calamansi farms are small and scattered throughout the archipelago. Pummelo, on the other hand, is grown on large contiguous farms in Mindanao. Papaya production is limited to the Visayas (central islands) and Mindanao, owing to the devastating ring spot viral disease in the northern island of Luzon. Despite this constraint, papaya has remained an important export crop.

According to Pantastico (1979), postharvest losses in fruit crops in the Philippines, averaged at 28% in 1979. Approximately 6% of fruit production was used either as feed or went to waste in 1985 (Statistical Handbook of Agriculture, MAF-BAECON, 1985). Attempts to provide realistic data on losses in fruits and vegetables were reported by Lizada (1990). Losses in bananas ranged from 4 to 60% and were caused by physical damage, green-soft disorder, weight loss, disease, and over ripening. Losses in the 'Carabao' variety of mangoes, ranged from 5 to 87% owing to stem-end rot, mechanical damage and rejection by mango exporters. Variability in national data on losses in these crops stemmed from the use of several loss assessment methods each with different objectives, as well as the manner in which data on losses was presented (Lizada, 1990).

POSTHARVEST LOSSES IN FRUITS

Banana

According to statistics reported by the Food and Agriculture Organization (FAO, 1998), the Philippines ranked 4th globally, and accounted for 6% of global banana production in 1998. Six important banana cultivars are produced in the Philippines, namely: Saba, Cavendish, Lakatan, Latundan, Bungulan and Cuarenta Dias. Saba accounts for 39% of the 4.2 million metric tons produced, followed by 'Cavendish' (32%), 'Lakatan' (13%), 'Latundan' (8%), 'Bungulan' (5%) and 'Cuarenta Dias' (2%).

Bananas of the Saba variety, a cooking variety, are an important raw material for processing into banana chips, an export winner product. Banana chip exports fluctuated between 1996 and 2000, with a peak export value of USD23.9 million in 1997. Hong Kong was the largest importer of banana chips followed by the United States and Japan. Other importers of banana chips during that period included the United Kingdom, Germany, Japan and the Republic of China (SAP for Banana, 2002).

Apart from the Saba variety, all other banana varieties are consumed in the fresh form. The Philippines is the largest supplier of bananas of the Cavendish variety to the Japanese market, supplying approximately 74% of Japan's banana imports. Bungulan, an evergreen variety, has found its niche in the Japanese market as an organically grown banana (Altertrade Report, 2002) and the demand for this variety is increasing. Banana imports from the Philippines, into the Peoples' Republic of China, were valued at approximately USD43 million in

2003 (ASEAN-China Free Trade Report, 2003). Lakatan, Latundan and Cuarenta Dias varieties are demanded in domestic markets, owing to their good eating qualities and to local consumer preferences for these varieties. These cultivars are also being promoted for export.

Studies on the postharvest handling of three banana varieties (Lakatan, Latundan, Saba) during their transit from major producing areas, to major markets in Manila, revealed losses ranging between 30 and 40% (IDRC, 1992; Lizada, 1993). Undersized or immature fruits, physiological disorders characterized by lumpiness, cracking, uneven ripening, and, physical damage due to compression, bruising and puncture, were the major causes of these losses during normal transportation. Physical damage was the major contributor to losses in bananas for fresh consumption. In the case of Saba varieties, premature ripening during transit was the major cause of rejection by processors who strictly require green, mature fruits (NAFC Report, 2003). According to Agravante et al. (1996), the large number of steps involved during the trading of bananas of the Cuarenta Dias variety result in bruising (78%), finger dropping (20.4%), immaturity (6.3%) and decay (2.9%), after three days as market outlets in Manila. No loss data are available for bananas of the Cavendish variety, which is primarily produced by multinationals that manage their farms and market their produce with minimal intervention from the Government.

Mango

Mangoes of the Carabao variety are of commercial importance to the Philippines owing to their exotic taste and high beta-carotene content. The Philippines accounted for 4% of the 24.3 million MT of mangoes produced globally during the period 1996–2000 and was the second largest exporter of fresh mangoes in the world after Mexico. It accounted for a 9% share of the global market on an annual basis for the 1995–1999 trading period. Mango exports from the Philippines for the period 1996 to 2001 averaged at about 41,356 metric tons on an annual basis. Export markets were Hong Kong (78%) and Japan (28%) (SAP for Mango, 2003).

The Philippine mango industry is characterized by wide variation in growing conditions and thus considerable variation in fruit quality. Fruit of exportable quality account for barely 50% of the total crop harvested, owing to the fact the crop is produced in backyards and on small farms (Esguerra et al., 2002). According to Esguerra et al. (2002), quality defects of pre-harvest origin (due to insect and disease, e.g., scab, sooty mold), account for between 8 and 13% of the total quantity harvested or delivered to packing houses. Postharvest quality problems and losses were the result of improper temperature control during postharvest handling, the inadequacy of support facilities and differences in handling practices at each stage of the postharvest chain. Diseases, in particular, stem-end rot and anthracnose, immaturity which predisposes the fruit to the development of internal breakdown (a physiological disorder) and physical damage brought about by inappropriate packaging systems are major causes of losses in mangoes (Esguerra et al., 2004).

Papaya

In the year 2000, approximately 121,304 MT of papayas were produced on a total area of about 8,500 ha (BAS, 2000). This production volume accounted for about 1% of the world's total annual outputs of 5.65 M metric tons. The ring spot viral infection (RSPV) in the northern island (Luzon) of the Philippines has limited the production of this important crop. Approximately 2,600 MT of the Solo variety produced in RSPV-free areas is exported in the fresh form to Korea, Japan, Hong Kong and Singapore (BAS, 2000). The Del Monte variety is included in canned fruit cocktails while the moderately RSPV tolerant Sinta hybrid is domestically consumed in the fresh form.

Papaya, either in the fresh or processed form, is consumed as a dessert fruit. It is also consumed as a vegetable in its immature form and is used as a raw material for the production of papain and extracts for use in the cosmetic industry.

Postharvest losses in papaya have been evaluated for the Solo type, given the potential of this variety as an export crop. According to Serrano et al. (1996), a commercial shipment of seven batches of papayas (each of which consisted of 1.2 tons of papaya) from Mindanao to a wholesaler's packing house in Manila sustained between 27 and 42 precent losses owing to pre- and post-harvest handling factors. The major contributing factors to these losses were misshapen fruit (26%); insect damage (2–16%); "evergreen" or immature fruit (3–20%); bruised, compressed and cut fruit (17–20%); diseased and prematurely ripened fruit (20–47%).

Citrus (*Calamansi*)

Calamansi (*Citrus microcarpa* Bunge) is a member of the citrus family and is produced primarily in the Philippines. It is a small round fruit measuring about two to three centimeters in diameter. It is green and assumes a yellow color on ripening. Calamansi produces a yellow to orange juice which has a distinctively sour taste. Calamansi extracts are applied in various food and non-food applications. Their food applications include use in the production of refreshing cold beverages, as flavor enhancers to main dishes (in particular seafoods), in food marinades and/or dips, in the production of candies, preserves or desserts such as sherbets and as hot beverages for the common cold. Their non-food applications include their use in stain removers, deodorants, skin bleaching agents, shampoos, and in the treatment of skin irritations.

The Philippines is the only major producer and exporter of calamansi, globally. During the five-year period 1996–2001, approximately 58,376 metric tons of calamansi were harvested from 13,319 hectares on an annual basis. The country's average annual calamansi exports increased by 66% from 85 metric tons in 1996, to 254 metric tons in 2000. Juices accounted for the largest volume (79%) of value-added exports derived from calamansi, followed by concentrate (17%), fresh (4%) and dried calamansi (1%). The United States was the major importer of Philippine calamansi exports, absorbing 42% of total exports or 81 metric tons. Other major importers of Philippine calamansi products were Japan (27%) and Republic of Korea (14%). Canada which ranked 4th and Hong Kong which ranked 5th, were consistent importers and showed increasing demand for these products (SAP for Calamansi, 2002).

The quality of calamansi at harvest is significantly reduced by scab infection, a pre harvest defect. Susceptibility to fungal diseases is enhanced by high relative humidity and poor sanitation during production. Scab-laden fruits are unsightly, are of low juice content and exhibit high levels of moisture loss (Serrano, 1998). Postharvest losses are due to: improper harvesting which results in over-trimmed fruits that are prone to disease infection; use of inappropriate maturity indices during harvesting which gives rise to small fruits with poor juice yields; mishandling which causes oleocellosis that downgrades appearance and increases susceptibility toward moisture loss and disease infection.

Pineapple

The Philippines is a major producer of pineapples, and accounts for 17% of global production of that fruit. The pineapple industry accounts for about 1.4% of total national agricultural production on an annual basis. In 1998, some 40,000 ha were under cultivation with a diversity of pineapple varieties, producing approximately 1.5 M tons of pineapples (BAS, 1999). Two pineapple cultivars, namely, *Smooth Cayenne* and *Queen or Formosa* are produced in the Philippines. Smooth Cayenne varieties are produced primarily by multinationals in Mindano, while both varieties are produced by small farmers in Luzon and the Visayas.

Pineapples are consumed in the fresh form, or are processed into juices/concentrates, cocktails, canned slices/chunks or tidbits, and dried fruit. In 1998, fresh pineapples exports amounted to 117,316 MT, valued at USD20.8 M, with Japan absorbing an 82.93% share of the total amount, followed by Korea (11.73%) and Hong Kong (3.17%). Exports of processed products during that period reached 253,639 MT valued at about USD120 M, with the US as the highest importer, absorbing 53% of the total export value (BAS, 1998).

Data on losses for the Smooth Cayenne variety are not accessible, owing to the fact that this variety is produced for multi-nationals. Postharvest handling and transportation of the Queen variety which is produced by small farmers throughout the country, have been studied with the objective of enhancing the competitiveness of this variety in local and export markets. The highest level of postharvest losses (28–40%) occurred due to rotting during retail marketing. Losses also occurred during storage (20–30%) due to diseases/rotting and during transport (10%) due to decay, compression and over-ripening. Pre-harvest losses were minimal (<1%) and were caused by rat or bird damage. Of the four marketing trials conducted, losses in the form of unmarketable fruits due to compression and spoilage were in the range of 24–36% (Serrano, 1998).

RECENT DEVELOPMENTS IN THE MANAGEMENT OF POSTHARVEST LOSSES IN PERISHABLE CROPS

In 1998, the Philippines enacted the Republic Act 8435 known as the Agriculture and Fisheries Modernization Act (AFMA) that provides for the country's blueprint for the sector's modernization and development. This Act defines the necessary policy environment and deliberate public investment stream that will transform the rural economy into one that is modern, science and technology-based, more integrated into the national and international markets, and thus highly productive and competitive (RA 8435 Doc., 1998). Embodied in the AFMA are provisions for reducing losses in agricultural commodities through:

(1) Establishment and modernization of postharvest, transport/logistic facilities to ensure efficient movement of commodities, maintain quality and reduce food losses;
(2) Capacity and capability strengthening and enhancement of agencies such as the Bureau of Postharvest Research and Extension (BPRE) of the Department of Agriculture and academic institutions such as the Postharvest Horticulture Training and Research Center (PHTRC) of the University of the Philippines Los Baños that are mandated to address RDE postharvest-related concerns;
(3) Establishment of the Bureau of Agriculture and Fisheries Product Standards (BAFPS) to establish grade standards and encourage quality consciousness that would meet both domestic and foreign market requirements; and,
(4) Establishment of a National Marketing Assistance Program (NMAP) that will support marketing and postharvest commerce of agricultural products.

APPROACHES AND TECHNOLOGIES TO REDUCE POSTHARVEST LOSSES IN FRUITS

Reduction of postharvest losses in perishable commodities necessitates an integrated approach to production, postharvest handling and marketing. Such an approach is embodied in a Quality Assurance Program (QAP) for each commodity, designed to meet consumer requirements of consistent quality and volume. QAP is a management system for controlling quality by establishing operational procedures involving the integration of procedures in production and post production, services and people concerned with the product. So far, QAPs for banana (Cavendish and Bungulan varieties), pineapple (Smooth Cayenne variety) and papaya (Solo variety) have been established and implemented by multinational companies involved in the production and export marketing of these commodities.

The Postharvest System Improvement (PSI) is an approach employed by the PHTRC for identifying postharvest problems, assessing the levels of losses and applying postharvest interventions to reduce or minimize losses in perishable crops. PSI employs the use of several methodologies in order to effectively attain the overall objective of reducing handling-related losses and maintaining fresh produce quality. These methodologies include: handling trials, quality profiling, establishment of packing houses that guarantee control and consistency of product quality and sustained volume, prior to marketing consolidated volumes of produce, and, establishment and implementation of quality standards. Improved postharvest handling systems (IPHS) for Saba bananas, Solo papayas, Carabao mangoes, Queen pineapples and *calamansi* have been established by PHTRC in cooperation with producers and the private sector. The benefit of IPHS can be realized if implemented by cooperatives, fruit clusters, or groups of producers.

The development of science-based postharvest technologies has been delegated to academic institutions such as the PHTRC and the DA-attached agency, such as the BPRE, whose mandate is to conduct research and development in the area of postharvest. Notable technologies that have been generated by these R&D institutions and that have had a significant impact in reducing postharvest losses in fruit crops are the following: (1) optimized hot water treatment protocols for the control of anthracnose and stem-end rot diseases in mangoes and papayas and for alleviating chilling disorders in Queen pineapples; (2) controlled atmosphere protocols (CA) to for delayed ripening of Carabao mangoes for export; (3) modified atmosphere (MA) packaging/storage protocols for delayed ripening and deterioration or papaya and *calamansi;* (4) waxing with fruit coatings synthesized and formulated from coconut oil for delayed ripening and to minimize the development of physiological disorders in pineapples and papayas; (5) cold chain systems at major trans-shipment routes; and (6) optimized quarantine protocols (vapor heat treatment and irradiation) for disinfestation against fruit flies without prejudice to the quality of fresh mangoes and papayas for export to Japan, the US, Australia and Korea.

Handling-related losses are the result of interaction of the commodity with physical and biological factors in the environment to which the commodity is subjected, and the manner in which the commodity is handled by the farmer, trader or laborer involved in preparation and marketing of the produce. Strengthening the capacity of postharvest handlers is one approach toward reducing postharvest losses. Awareness training and transfer of postharvest technologies to stakeholders in the fruit industry will also enhance the capacity of handlers.

NATIONAL ISSUES AND PROBLEMS IN REDUCING POSTHARVEST LOSSES AND SOME RECOMMENDED CORRECTIVE MEASURES

Reducing postharvest losses is one of the key measures to achieving food security and poverty alleviation. The national significance of reducing postharvest losses is highlighted by loss reduction programs being developed and implemented by the Philippine government. Attainment of the national goal of reducing postharvest losses is, however, constrained by a number of issues and problems:

Issue #1

Support for the improvement of postharvest research and development is limited, and not sustained. Given the science-based nature of postharvest technologies, support from both the private sector and government is required for its development. The private sector lacks commitment or sometimes does not want to provide counterpart support for the development of postharvest technologies and improvement of postharvest handling systems.

Recommended Measure: Government support is required to strengthen the capacity of institutions to undertake research in the area of postharvest. At the same time, private sector should support postharvest research and development. Within this context, governments should promote and encourage private investment in postharvest research and development which complements public investments for enhancing productivity.

Issue #2

The production-distribution continuum in the Philippines is disjointed or fragmented owing to the archipelagic geographical nature of the country. Supply chains for perishable crops are consequently fragmented and losses and distribution costs are high. The existing distribution system is inefficient due to lack of functional postharvest facilities, poor infrastructure and a weak policy environment.

Recommended Measure: Governments should support and strengthen the capacity of cooperatives and encourage cooperative marketing of those crops which are produced on small farms (bananas with the exception of 'Cavendish', mangoes, calamansi and 'Queen' pineapples). Cooperative arrangements would facilitate production scheduling, meeting volume and quality requirements and direct marketing, with fewer intermediaries in the supply chain. Governmental support is also required for the improvement of infrastructure such as farm to market roads, cold chain systems, trading/collection centers and postharvest facilities such as packing houses and storage facilities so as to enhance efficiency in the distribution system thereby assuring consistency of fresh produce supplies to larger areas of the country.

Issue #3

Quality standards developed for fresh fruits are used on a voluntary basis.

R*ecommended Measure*: Through the Bureau of Agriculture and Fishery Product Standards, a scheme or system of product standard enforcement, accreditation and inspection should be implemented.

Issue #4

Marketing support systems in terms of price information are weak, unreliable or are totally lacking. Price information is important to producers in formulating marketing strategies in order to maximize the returns from their produce. Whether the product should be stored or not or should be transported to distant markets to take advantage of a higher price would be influenced by the market price of the product.

Recommended Measure: A National Marketing Assistance Program should be established by the Government. This Program should focus on providing timely and reliable market information to producers.

IMPROVEMENT OF POSTHARVEST SYSTEMS TO REDUCE LOSSES IN ‘SOLO’ PAPAYA: A CASE STUDY

In anticipation of lifting the export ban on Solo papaya to Japan, a postharvest system improvement project, funded by the Australian-ASEAN Economic Cooperation Programme (AAECP) through the Australian-ASEAN Postharvest System Improvement Project (AAPSIP), was implemented by the PHTRC in 1991. The project aimed to improve the handling of ‘Solo’ papaya produced in Mindanao, with the ultimate objective of reducing losses, maintaining the quality of papaya fruits and expanding international markets for this highly demanded crop. The Balingasag Integrated Farmers’ Multipurpose Cooperative (BIFAMCO) which consists of 32 ‘Solo’ papaya growers in Balingasag, Misamis Oriental was chosen as the project counterpart.

Being an action research project, this project made use of PSI methodologies to attain the project’s specific and main objectives. A rapid appraisal (Regalado et al., 1996) of postharvest handling of papayas from Mindanao to Manila brought into focus the traditional handling system (Figure 1), problems in handling and distribution, the magnitude and cause of losses and the quality profile of papayas at each point of the marketing chain (Tables 2a, 2b). Between 27 and 44% of the papayas were determined unmarketable, from a total of ten shipments (5 tons of papayas).

On the basis of these findings, a number of technologies which offer potential for reducing handling related defects, such as compression, bruising, premature ripening and diseases, were evaluated through a series of trials. Technologies tested included: 1) modified atmosphere packaging (MAP) technology using a polyethylene bag to minimize moisture loss and extend green life (or retard ripening); 2) hot water treatment of ‘ever-green’ or immature fruits that failed to ripen normally; 4) optimization of low temperature storage conditions; 5) optimization of the stage of ripeness to obtain quality characteristics when subjected to quarantine disinfestation through vapor heat treatment (VHT); and 6) use of rigid packaging containers (wooden crates) to reduce compression/bruise damage.

Table 2a. Quality Profile of ‘Solo’ Papaya from Misamis Oriental Evaluated at Different Market Outlets, prior to Postharvest System Improvement (AAPSIP Project Report, 1993)

Attributes	Wholesaler’s Packinghouse (Manila)	Retail Outlet (Simulated at PHTRC)
Peel color index	4.2 (4 d after harvest)	4.8 (6 d after harvest)
Cuts/bruises (%)	22.1	25.5
Diseased incidence (%)	14.2	15.7
Compression (%)	32.2	39.4
Immature (%)	10.0	-
Overripe (%)	8.4	-

Total number of fruits evaluated = 690 equivalent to 17 crates

Table 2b. Percent Rejects of Papaya Fruits at Manila Wholesaler's Packing House before Improvement of the Handling System (1993)

Date of Shipment	Volume (Kg) Received by the Wholesaler	Unmarketable Fruits (% of total weight)
January 3, 1993	2,524	40
January 6, 1993	2,688	27
January 10, 1993	2,058	44
January 13, 1993	2,540	31
January 20, 1993	2,261	41
January 24, 1993	1,045	31
January 27, 1993	1,734	42
Total	14,850	

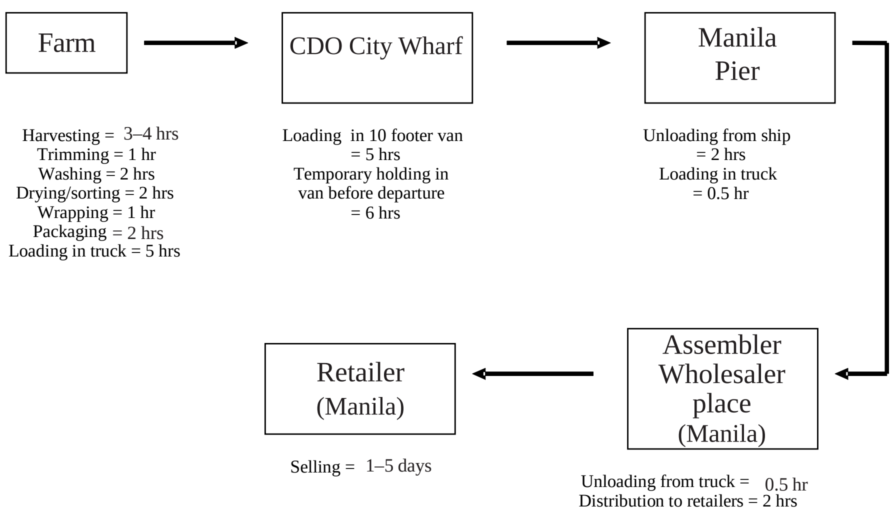

Figure 1. Traditional Postharvest Handling Operations and Time Involved at Each Point in the Distribution Chain of "Solo" Papaya from Misamis Oriental

Table 3. Quality Profile of 'Solo' Papaya Fruits Shipped from Misamis Oriental to Wholesaler's Packinghouse after Postharvest System Improvement

	PCI4 DAH	Bruises (%)	Compression (%)	Diseased (%)	Latex Exudation	Evergreen
Feb. 23, 1993[a]	4.6	4.5	7.5	2.2	23.9	0.8
Mar. 9, 1993[b]	4.2	11.6	7.9	1.3	8.4	1.2
Apr. 6, 1993[C]	4.3	10.8	3.1	0.7	16.3	-

(a) Total no. of fruits = 1,482 (39 crates); b) Total no. of fruits = 594 (18 crates);
(C) Total no. of fruits = 258 (6 crates)

These evaluations led to the establishment of an improved handling system (Figure 2) which was tested on several shipment trials. Losses were reduced from between 27 and 42%

to about 3% (Table 3) with the improved postharvest handling system. Follow up shipments showed that re-sorting at the wholesaler's packing house was no longer required and that the cooperative was able to establish its credibility in providing good quality fruits with minimal damage and defects as shown by retailers buying fruits from the wholesaler without even opening the wooden crates (Serrano, 1994).

The improved postharvest handling system for papaya has been widely disseminated to papaya stakeholders. It is now being followed/used by exporters of papayas to Singapore and Hong Kong.

Maturity Index

- When tips and sides between ridges show tinge of yellow (peel color index 2)

Harvesting

- Use knife, clipper or plumber's friend to reach tall trees
- Harvest between 9 am and 3 pm
- Place harvested fruits in padded containers to prevent bruising

Market Preparation

1. Wash with water mixed with 1% alum (10 tbsp in 10 liters) to remove latex and chemical residues
2. While washing, do preliminary sorting. Discard diseased, damaged, and poor- quality fruits
3. Trim stem close to shoulder
4. Air-dry or cure for about 12 hours to minimize latex exudation on the peel when ripe
5. Sort fruits according to size
6. For disease control, dip fruits in hot water (49–51°C for 10 minutes) or in 0.1% thiabendazole for 1 minute

Packaging

Local Markets

- Half-wrap fruits with newspaper
- Pack in 20–22 kg capacity wooden crates with newspaper lining
- For inter-island transport, pack in polyethylene bags with 18 pinholes and 6 ethylene adsorbents to delay ripening during transit

Export Markets

- For Japan and Korea markets, subject fruits to vapor heat treatment (46°C, 70 min.)
- Use onion skin paper to wrap fruits and arrange them in single layers with stem-end down
- Pack in carton boxes with or without dividers but with cushions

Figure 2. Improved Postharvest Handling System for 'Solo' Papaya

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18. PHILIPPINES (2)

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INTRODUCTION

The Philippines, a predominantly agricultural country, has a generally warm and humid climate throughout the year. Its mean annual temperature is approximately 27°C (80°F). Approximately 90% of the country receives more than 1,780 mm (70 inches) of rainfall on an annual basis.

Agriculture remains one of the major contributors to economic growth of the Philippines, accounting for about 15% of the GDP. Agricultural production at current market prices is currently valued at pesos (PHP) 664.7 billion, registering an annual growth rate of 3.77% as reported by the Bureau of Agricultural Statistics (BAS, 2004). It provides employment to about 37% of the total labor force and to one-fifth of the estimated 50 million people living in rural areas.

The vegetable sector is a vital component of Philippine agriculture. In 2003, twenty-two different kinds of vegetables of economic significance were produced on 120,315 hectares (Table 1). This area of production represents almost one percent of the 13 million hectares devoted to agricultural production. Fresh vegetable production for the period 1999 to 2003 is shown in Table 2. The production volume of fresh vegetables in 2003 amounted to 1.06 million mt, valued at PHP4, 464 million and represented 1.35% of total crop production. The top five vegetables in terms of production volume are eggplant, tomato, squash, onion and cabbage.

Approximately 36,562 mt of fresh vegetables, which included bulb onions, shallots and asparagus, valued at USD15.45 million on FOB basis (Tables 3 and 4) were exported in 2003. However, in order to augment local supply, the country also imported fresh vegetables totaling 2,140 mt in the same year, valued at USD0.5 million FOB (Tables 5 and 6). The Philippines, is, therefore, a net exporter of fresh vegetables.

Vegetable production systems in the country can be grouped into three categories: 1) production systems for home consumption, 2) production as a secondary crop after harvest of the primary crop such as rice or corn, and 3) production on a full scale-specialized basis. Vegetable production for home consumption is widespread, but is of relatively little significance from the marketing point of view. Vegetables grown as a secondary crop are generally produced in rain-fed areas or in mono-crop rice or corn producing areas, particularly in the central plains of Luzon. These vegetables are planted following the harvesting of the primary crop. On the other hand, specialized vegetable production is mostly found in the highlands of the Cordillera Administrative Region (CAR) in Luzon and in some areas of high elevation in the Visayas and Mindanao, where the cool climate, rainfall levels and fertile soil favor production on a year-round basis. These areas are the main sources of semi-temperate vegetables such as cabbages, carrots, lettuce, potatoes, broccoli, celery, cauliflower, etc.

The introduction of modern high yielding varieties and advances in production technologies have increased vegetable production in the country. However, high losses in the postharvest handling chain practically negate the impact of these increased yields, owing to the fact that the vegetable postharvest sector has not kept pace with development of the production sector. Increases in production have placed a burden on existing capacity for postharvest handling of vegetables which are highly perishable.

Table 1. Area (ha) Planted/Harvested of Major Vegetable Crops in the Philippines, 1999–2003

Crop	1999	2000	2001	2002	2003	% Annual growth rate (ave)
Eggplant	19,386	19,949	20,422	20,813	20,984	2.06
Tomato	16,808	16,692	16,496	16,698	16,779	(0.04)
Onion	9,602	9,579	10,094	10,035	9,516	(0.22)
Bitter gourd	8,004	7,939	8,291	8,412	8,456	1.41
Squash	7,922	7,865	8,128	8,141	8,236	0.99
Cabbage	7,637	7,672	7,711	7,802	7,746	0.36
Pechay native	6,539	6,708	6,712	6,854	7,158	2.37
Garlic	3,799	5,269	5,707	5,637	5,459	10.92
Carrots	3,205	3,414	3,441	5,536	3,505	2.34
Potato	5,242	5,172	5,322	5,366	5,394	0.72
Ginger	3,279	3,583	3,681	3,642	3,610	2.52
Bagiuo beans	3,114	3,060	3,009	3,078	3,098	(0.13)
Gourd	3,180	3,091	2,954	3,040	3,502	2.53
Okra	2,729	2,907	2,972	3,024	3,018	2.65
Pechay chinese	2,989	2,986	3,031	3,003	2,998	0.08
Chayote	2,692	2,753	2,809	2,969	2,984	2.71
Bell pepper	2,076	2,225	2,274	2,381	2,377	3.62
Asparagus	1,423	1,502	1,784	2,270	2,471	18.41
Finger pepper	1,521	1,612	1,662	1,687	1,666	2.38
Cauliflower	943	961	989	972	982	1.03
Lettuce	215	207	211	209	216	0.12
Broccoli	160	156	157	158	160	0.00
Total	112,465	115,302	117,857	121,727	120,315	1.74

Source: Bureau of Agricultural Statistics

Over the past few decades, various national and international meetings and conferences have focused on addressing the issue of postharvest food losses. Loss assessment studies for vegetables were undertaken by various agencies in the early 1980s. Despite these developments, data on the patterns, magnitude and causes of postharvest losses remain highly variable and the level of losses reported is alarmingly high. Enormous difficulty in accurate measurement during the assessment of losses is a contributor to the discrepancy. It should be noted that loss estimates are to a degree commodity-, location- and season-specific, and technology- and practice-dependent, which makes the concept of average postharvest losses, meaningless.

Table 2. Volume (Mt) of Major Vegetables Produced during the Period 1999–2003

Crop	1999	2000	2001	2002	2003(R)	% Annual growth rate (ave)
Eggplant	159,744	166,146	169,819	179,659	176,997(1)	2.70
Tomato	145,362	148,101	146,031	149,259	150,059(2)	0.81
Onion	84,967	84,216	82,606	96,358	93,843(4)	2.61
Bitter gourd	43,489	44,366	47,124	48,847	49,129(7)	3.24
Squash	110,809	106,023	113,432	117,673	122,561(3)	2.65
Cabbage	87,472	87,576	89,542	91,368	91,982(5)	1.29
Pechay native	36,417	37,365	37,00	39,684	41,288(8)	3.34
Garlic	9,335	13,688	15,364	16,257	15,529(15)	16.59
Carrots	33,849	34,600	33,793	34,512	34,666(11)	0.60
Potato	63,584	63,524	66,016	67,540	68,050(6)	1.76
Ginger	20,793	22,679	23,424	23,022	22,616(14)	2.19
Bagiuo beans	12,138	11,757	11,603	11,847	11,549(18)	(1.21)
Gourd	38,107	37,113	34,980	33,926	33,867(12)	(2.78)
Okra	25,174	25,452	25,160	25,254	22,992(13)	(2.17)
Pechay chinese	35,939	34,220	35,307	34,885	34,894(10)	(0.73)
Chayote	38,876	38,027	39,264	40,879	41,135(9)	1.45
Bell pepper	9,566	9,862	9,797	10,162	10,325(19)	1.98
Asparagus	6,332	6,429	8,577	12,566	15,211(16)	35.06
Finger pepper	3,790	4,050	4,246	4,568	4,539(20)	4.94
Cauliflower	11,999	12,180	12,298	12,284	12,324(17)	0.68
Lettuce	1,439	1,421	1,475	1,495	1,579(22)	2.43
Broccoli	1,616	1,571	1,607	1,634	1,669(21)	0.82
Total	980,797	990,366	1,008,465	1,053,679	1,056,804	1.94

Source: Bureau of Agricultural Statistics
R= rank

Table 3. Quantity (Mt) of Fresh Vegetables Exported during the Period 1999–2003

Vegetable	1999	2000	2001	2002	2003	% Annual growth rate (ave)
Onion	2,046	3,724	-	264	2,893	10.35
Asparagus	4,169	3,974	4,148	4,663	3,644	(3.15)
Shallot	4,505	11,143	5,614	16,033	30,025	141.62
Total	10,720	18,841	9,762	20,960	36,562	60.27

Source: Bureau of Agricultural Statistics

Table 4. Value (in USD FOB) of Fresh Vegetables Exported during the Period 1999–2003

Vegetable	1999	2000	2001	2002	2003	% Annual growth rate (ave)
Onion	1,216,020	1,719,870	-	66,935	861,240	(7.29)
Asparagus	10,173,860	9,616,300	10,138,250	10,020,908	7,873,950	(5.65)
Shallot	1,741,910	2,332,700	1,033,320	3,234,347	6,715,870	71.39
Total	13,131,790	13,668,870	11,171,570	13,322,190	15,451,060	4.41

Source: Bureau of Agricultural Statistics

Table 5. Volume (Mt) of Fresh Vegetables Imported during the Period 1999–2003

Vegetable	1999	2000	2001	2002	2003	% Annual growth rate (ave)
Carrot	18	57	32	647	1,347	1,845.83
Celery	8	17	-	5	2	(18.75)
Cauliflower/Broccoli	112	6,726	310	610	271	35.49
Cabbage	237	1	36	69	83	(16.24)
Lettuce	310	691	369	215	140	(13.71)
Lettuce, leaves	118	151	85	215	140	4.66
Mushroom	54	44	79	62	154	46.30
Leeks	3	10	2	1	3	0.00
Total	860	7,697	913	1,824	2,140	37.21

Source: Bureau of Agricultural Statistics

Table 6. Value (in USD FOB) of Fresh Vegetables Imported during the Period 1999–2003

Vegetable	1999	2000	2001	2002	2003	% Annual growth rate (ave)
Carrot	10,490	21,480	17,250	109,490	221,650	503.24
Celery	4,640	6,600	-	6,760	1,760	(15.52)
Cauliflower/Broccoli	45,620	703,780	163,520	146,380	83,070	20.52
Cabbage	83,750	300	6,410	13,110	13,700	(20.91)
Lettuce	158,830	257,860	271,390	98,140	54,850	(16.37)
Lettuce, leaves	43,210	44,450	45,370	98,140	54,850	6.73
Mushroom	41,590	21,020	44,920	200,810	67,400	15.51
Leeks	1,550	6,660	4,040	2,130	3,140	25.64
Total	389,680	1,062,150	552,900	674,960	500,420	7.10

Source: Bureau of Agricultural Statistics

POSTHARVEST LOSSES IN VEGETABLES

Loss Assessment Studies in the 1980s

Like fruits, vegetables are perishable crops. These crops deteriorate very rapidly after harvest owing to a number of factors. Quantitative losses, which are readily measurable, occur as a result of reduced weight due to product decay and senescence. Qualitative losses occur due to deterioration in texture, flavor and nutritional value (Liu, 1999). These forms of losses can be translated into monetary loss due to reduced prices.

The cited average value of postharvest losses of vegetables in the Philippines is 42% (Pantastico, 1980). However, Lizada (1990) noted that there is a paucity of loss estimates that bear this average figure out. Interestingly the supply and utilization accounting on vegetables performed by the BAS for the period 1990–2003 shows relatively low values ranging from 3.7 to 8.6% as the proportion of production that goes to feeds and wastes. There is some debate as to whether this range of losses is realistic. Loss assessment studies conducted on vegetable crops in the 1980s are reviewed and discussed below.

Tomato

A summary of the loss estimates for tomatoes and their sources is given in Table 7. Loss studies conducted by the Postharvest Horticulture Training and Research Center (PHTRC) on the tomato cultivar Improved Pope, shipped from Claveria in Mindanao to Los Baños, Laguna in Luzon, losses ranged from 4 to 8%. This transport loss was based on the proportion of rotten fruits as well as diseased and severely damaged fruits. Weight (moisture) losses after ripening of sound fruits, slightly damaged fruits and fruits with severe abrasions were found to be 7.9%, 18.0% and 58.6%, respectively (Barile and Esguerra, undated as cited by Lizada, 1990). Mangaoang (1982) reported a postharvest loss of 11.9% and a post-storage loss of 12.1% amounting to a total postharvest loss of 24%. The effect of tomato cultivar on transport loss from Claveria to Los Baños can be gleaned from the unpublished results of Fuentes et al. as cited by Lizada (1990). ‘BPI-TM2’, a less popular tomato cultivar among farmers in Claveria owing to the fact that it is more highly prone to damage than ‘Improved Hope’, incurred a total transport loss of 16%, which was about twice that of the latter.

Onion and Garlic

Data on postharvest losses for onion and garlic are very limited. Loss values for onion and garlic subjected to various storage methods are shown in Table 8. Storage methods investigated were: cold storage at 0°C and storage with rice hull or saw dust. In the study of Lantican et al. (1988) as cited by Lizada (1990), losses in onion bulbs (Red Creole) stored for 4 months at 0°C, varied between 12 and 38%. Extending the storage period beyond 6 months resulted in an increase in the range of losses from 22–98%. Vizmonte, working on Yellow Granex onion cultivars, reported losses of 27.3% and 36.4% for four months of storage in sawdust and rice hulls, respectively. Losses were based on non-marketable onion bulbs. Mangaoang (1982) reported postharvest loss and post-storage loss of 44.8% and 7.1%, respectively in onions. The only available data available in the case of garlic was reported by Mangaoang (1982) who determined postharvest losses and post-storage losses of 31.5% and 11.8%, respectively.

Cabbage

Loss assessments had in the past focused on the transport of cabbage from major production areas in the highlands of CAR to consumption centers in Metro Manila. Results of several loss assessment studies are presented in Table 9. Transport trials by Bantoc et al. (1983) from La Trinidad trading post to different drop off trading centers in Metro Manila showed losses ranging from 10 to 27%. In the study of Brena et al. (1985), transporting cabbage from the production area in Mt. Data to La Trinidad then onward to Divisoria, Metro Manila resulted in a 33.8% loss. This high level of loss was partly attributed to some pilferage at the Divisoria wholesale market. Manto (1980) compared the extent of losses in cabbage during handling and distribution from production farms in Benguet to the Divisoria wholesale market during hot-wet periods (July–October), cool-dry periods (December–February) and hot-dry periods (March–May). Results showed that during hot-wet period the losses ranged from 22 to 26% while during cool-dry periods they ranged from 15 to 18%. The difference was attributed to higher weight loss and decay caused by diseases under the hot-wet conditions. Ilag and Borromeo (1983) reported a 34% loss during the transportation of cabbage from La Trinidad to Los Baños, Laguna. Spraying the heads after trimming and prior to transportation, may very well have contributed partly to the high loss.

Table 7. Loss Estimates for Tomato[1]

Source	Cultivar	Route	Loss (%)[2]	Remarks
Labios et al. (1984)	Improved Pope	Claveria to Los Baños	5.0	Loss was based on amount of rotten fruits.
			3.0	Loss was based on fruits with severe damage.
Esguerra et al. (1984)		Claveria to Los Baños	4.0 (3.4)	Wooden crates contained 27 kg of fruits.
			9.0 (4.2)	Crates contained 30 kg of fruits.
			0.5	Liners were used during the shipment.
Bautista et al. (unpublished)	Improved Pope	Claveria to Los Baños	7.7	Loss was based on diseased and severely damaged fruits.
Quintana & Esquerra (unpublished)	Improved Pope	Batangas to Los Baños	1.6 7.8 (6.2)	Loss was based on amount of rotten fruits 7 and 10 days, respectively.
Barile and Esguerra (unpublished)	Improved Pope	Claveria to Los Baños	(7.9)	Sound fruits kept for an additional 6 days after arrival (unpublished). Fruits ripened to an average peel of 5 (traces of green).
			(18.0)	Average obtained from fruits with slight damage (bruises, abrasions).
			(58.6)	Value was obtained from fruits with severe abrasions.
Fuentes et al.	BPI-TM2	Claveria to Los Baños	16.0	Loss was based on fruits rendered unmarketable by mechanical damage and disease. Evaluation done upon arrival.
Mangaoang (1982)			11.7	Value is ‘postharvest loss’.
			12.1	Value is ‘post-storage loss’.

[1] Adapted in part from Lizada (1990); [2] Values in parenthesis represent weight loss.

Table 8. Loss Estimates for Onion and Garlic[1]

Source	Cultivar	Location	Loss (%)	Remarks
Onion				
Lantican et al. (1983)	Red Creole	Traders	12–38	Bulbs were taken from cold storage after four months.
			22–98	Bulbs were taken from cold storage after six months.
Mangaoang (1982)			44.8	Value represents ‘postharvest loss’.
			7.1	Value represents ‘post-storage loss’.
Vizmonte (1982)	Yellow Granex	Nueva Ecija	27.3 36.4	Values represents amount of unmarketable bulbs after four months in sawdust and rice hull, respectively.
Garlic				
Mangaoang (1982)			31.4 11.8	Value is ‘postharvest loss’. Value is ‘post-storage loss’.

[1] Adapted in part from Lizada (1990)

Table 9. Loss Estimates for Cabbage[1]

Source	Route	Period	Loss (%)	Remarks
Manto and Darrah (1979)	Benguet farms | Manila wholesale market	hot-wet cool-dry	25.5 17.5	Crates (22–47) weighing 60–67 kg each were sampled.
Manto (1980)	Benguet farms | Manila wholesale market	hot-wet cool-dry hot-dry	21.5 15.4 19.8	
Brena (1985)	Mt. Data —> La Trinidad		1.9	Heads with wrapper leaves on were transported in bulk along the route where they were subjected to usual trimming prior to transport to Manila. Loss was estimated from the difference in % trimming between carefully transported heads and heads handled in the usual manner.
Brena et al. (1985)	Mt. Data —> La Trinidad		2.1	Evaluation was done immediately after arrival (day of harvest).

(To be continued)

	to Divisoria		30.4	Evaluation was done two days after harvest; pilferage was reported.
	to Los Baños		22.3	Evaluation was done 2 days after harvest; higher loss was attributed to insect damage.
	Buguias —> La Trinidad		1.6	See remarks on transport trial from Mt. Data to La Trinidad.
Bantoc et al. (1983)	La Trinidad —> FTI Taguig —>			
	Paco/Tayuman/Philtrade Kadiwa Center		21.2	Heads were packed in octagonal wooded crates (taken from 15 crates containing 12–14.5 kg/crate).
			26.7	Heads were packed in bamboo baskets (taken from 10 baskets containing 60–70 kg/basket).
	Caloocan Kadiwa Center		10.2	Heads were packed in wooden crates (5 crates).
	Cubao Kadiwa Center		19.5	Heads were packed in wooden crates (2 crates).
			24.6	Heads were packed in bamboo baskets (4 baskets).
	La Loma Kadiwa Center		23.8	Heads were packed in bamboo baskets (2 baskets); loss was attributed mainly to insect damage and mechanical injury; disease was minimal.
Ilag and Borromeo (1983)	La Trinidad —> Los Baños		33.8	Heads were trimmed, then sprayed with water.
Mangaoang (1982)			24.9	Value is 'postharvest loss'.
			26.5	Value is 'post-storage loss'.

[1] Adapted in part from Lizada (1990)

Recent Estimates of Postharvest Losses

Yaptenco et al. (2001) conducted simulated handling trials to estimate losses during refrigerated and unrefrigerated transportation of selected vegetables from La Trinidad, Benguet to the PHTRC laboratory in Los Baños. Vegetables transported under refrigerated conditions were stored at 13–15°C and under ambient conditions for 7 days. Non refrigerated vegetables were stored under ambient conditions for the same period. Results showed that weight loss was less in produce transported at low temperatures and stored in a cold room than that transported in a non-refrigerated truck and stored under ambient conditions (Table 10). As was expected, the vegetables transported under refrigerated conditions and stored under ambient conditions, incurred a higher weight loss. Pre-cooled vegetables which rewarmed and wet, often decay at a more rapid rate, than those that have not been cooled at all. This has been a major cause of failure in the past, where refrigerated trucks have been used for vegetable transport, with a break in the "cold chain" at the traditional retail market.

BPRE's baseline survey (Ramos et al., 2003) of vegetable farmers in Benguet and Mt. Province in the CAR and traders plying the Benguet-Manila supply route provided some estimates of physical losses in selected vegetables (Table 11). The highest total loss was observed for lettuce (34.4%), while the lowest was for snap beans (8.8%). For vegetables grown in Bukidnon, Northern Mindanao, the FAO funded Farm Income Diversification and Market Development Project (FIDMD) conducted a survey of vegetable growers in 2003 and reported postharvest losses ranging from 10% for broccoli and cauliflower to 25% for lettuce and cabbage (Table 12). The major causes of these losses were rough handling, improper harvesting methods and delayed produce handling.

Table 10. Physical Loss (moisture loss and trimmings) for Selected Vegetables Transported from La Trinidad, Benguet to Los Baños, Laguna and Stored for 7 Days, 2001

Commodity	Refrigerated transport		Non-refrigerated transport
	Cold storage Loss (%)	Ambient storage Loss (%)	Ambient storage Loss (%)
Bell pepper	4.8	6.3	15.6
Broccoli	8.4	25.7	20.6
Cabbage	23.8	40.3	31.4
Chinese cabbage	11.5	14.0	17.3
Carrots	12.0	14.0	16.0
Cauliflower	4.0	26.4	44.0
Celery	15.3	26.9	26.5
Leeks	10.6	30.0	35.3
Lettuce	10.5	21.1	21.7
Peas	10.0	13.5	11.6

Source: Yaptenco et al. (2001)

Table 11. Physical Losses (%) of Highland Vegetables from Production Areas (CAR) to Retail Outlets in Metro Manila as Reported by Farmer- and Trader-Respondents, 2001–2002

Commodity	Farms to La Trinidad	La Trinidad to Metro Manila	
Total	(n=270)	(n=116)	(loss %)
Beans	7.4	1.4	8.8
Broccoli	11.6	-	-
Cabbage	10.9	5.5	13.6
Chinese cabbage	7.2	2.8	10.0
Carrot	11.0	5.1	16.1
Cauliflower	10.9	1.5	12.4
Celery	13.1	6.6	19.7
Leeks	14.0	-	-
Lettuce	24.4	10.0	34.4
Potato	8.0	1.3	9.3
Sweet pea	5.3	-	-
Bell pepper	6.0	-	-
Tomato	14.0	-	-

Source: Ramos et al. (2003)

Table 12. Postharvest Losses for Selected Vegetables as Reported by Growers in Bukidnon, Northern Mindanao, 2003

Commodity	Loss (%)	Remarks
Broccoli	10	* Caused by rough handling
Cabbage	25	* Improper harvesting methods; rough handling; delay in handling produce
Carrots	20	* Rejects due to cracks; mechanical damages/bruises
Cauliflower	10	* Rough handling
Lettuce	25	* Bruises and trimmings

Source: Farm Income Diversification and Market Development Project, 2003

Salda et al. (2004) conducted a comprehensive study on postharvest loss assessment in vegetables commonly produced in the CAR. Losses were measured at different handling points from harvesting up to the retail market. The nature and causes of the losses at all handling points were noted. Table 13 presents the actual total percentage of physical losses with the corresponding nature and cause(s) of the losses. It can be seen that losses ranged from 1.7% for sweet pea to 19.6% for lettuce, which was way below the often-cited average value of 42% for vegetables in the Philippines.

Table 13. Actual Total Percentage and Nature/Cause of Physical Losses of Selected Highland Vegetables at Different Handling Points from Production (CAR) to Retail Outlets in Metro Manila, 2004

Commodity	Loss (%)	Nature/Cause
Cabbage	18.8	* Slight injuries and wilting during harvesting * Mechanical damage/injury due to careless handling at trading post in La Trinidad * Weight loss; slight damage; yellowing; trimming at wholesale level * Trimming; yellowing; wilting of outer leaves at retail
Chinese cabbage	9.8	* Wilting and slight mechanical injury during harvesting and hauling * Weight loss; wilting; mechanical damage at trading post * Weight loss; yellowing of leaves; trimming at wholesale and retail levels
Lettuce	19.6	* Slight mechanical injury during harvesting and hauling * Weight loss; slight damage at trading post * Weight loss; wilting; mechanical injury at wholesale/retail outlets
Celery	8.1	* Cut stem due to careless pulling of whole plant * Trimming during packing * Trimming; yellowing and wilting of leaf tips at retail outlet
Broccoli	21.1	* Mechanical injury of florets due to poor handling using sacks; weight loss due to sun exposure during harvesting * Leaves and stalk trimming at trading post * Yellowing of leaves; stalk trimming at wholesale outlet * Yellowing; stalk trimming; florets opening; slight insect damage at retail
Cauliflower	19.1	* Mechanical damage during hauling to collection point * Dark discoloration; trimming at trading post * Discoloration due to bruises/injuries; trimming at wholesale outlets * Discoloration; slight insect damage; trimming at retail
Sweet pea	1.7	* Broken pods due to careless harvesting * Rotting due to insect damage at retail
Bell pepper	5.5	* Mechanical damage due to careless harvesting; accidental stepping on commodity * Mechanical damage, e.g., small cracks, scratch marks and other injuries at trading post
Carrots	13.7	* Mechanical damage during harvesting * Accidental dropping of commodity during hauling * Slight cracks; bruises; deformed carrots at trading post * Mechanical damage; bruises; decay due to poor handling at wholesale outlet * Weight loss, skin drying, discoloration at retail
Potato	12.5	* Mechanical injuries during harvesting; bruises and moderate greening at wholesale outlet; weight loss at retail level

Source: Salda et al. (2004)

Management of Postharvest Losses: Some Recent Developments

In an effort to reduce postharvest losses and to produce high quality vegetables destined for high end markets at urban centers such as Manila in Luzon and Cebu in the Visayas, the government through the DA has embarked on a national cold chain program. The program is being implemented by the BPRE and its collaborating agencies which include the PHTRC, DA-Agribusiness Marketing Assistance Service, DA-Regional Field Units, DA-High Value Commercial Crops Program, and concerned local government units (LGUs). The objective of the program is to establish pilot cold chain systems that are integrated with the production and marketing operations of organized small vegetable farmers. It is envisioned that after demonstrating the viability of cold chain technology in small vegetable farming systems in the Philippines, the private sector will be encouraged to invest in cold chain systems and participate in the development of the vegetable industry.

The cold chain system works on the principle that keeping produce at low temperatures slows down its rate of respiration and minimizes deterioration, thus prolonging its shelf life. It includes all individuals involved in the handling, storage and transport of perishable produce. These stakeholders are farmers and their workers, packers, transport service crew including drivers, wholesalers, distribution agents, retailers, and consumers. Facilities in a cold chain system include pre-coolers, packinghouses and cold storage rooms and refrigerated trucks/containers for transport.

Traditional or alternative trade routes for semi-temperate, high value vegetable produce from major production areas, and destined for high end markets in Metro Manila, Cebu City and Davao City, are covered by the program. Three of the four major routes under current development are as follows:

Benguet to Manila Line The trade route originating from Benguet to La Trinidad Trading Post, and then down to Manila via Pangasinan, Tarlac and Pampanga. This supply route is the largest source of semi-temperate vegetables in the country. A majority of vegetables find their way to local markets in metropolitan Manila. A portion of the vegetables arriving in Manila is further distributed to adjoining provinces of Luzon and the Visayas.

Visayas Inter-island Connections The Visayas has a relatively smaller production volume of high value semi-temperate vegetables. Production is carried out in the highlands of Panay, the northern part of Negros surrounding Mt. Kanlaon, and areas of high elevation in the province of Cebu. Generally, the vegetables are marketed only in nearby cities on the islands where they are produced. A small percentage of the production is brought to Cebu City, or is alternatively shipped to neighboring islands/provinces. Occasionally, Iloilo growers deliver some of their vegetables to Manila.

Mindanao-Cebu-Manila Line Mindanao has the largest arable land area suited to the production of high value crops such as vegetables. Relatively limited quantities of fresh farm produce are able to reach the high end markets of Manila. The improved land route from Davao City to Cagayan de Oro (CDO) and the interconnections offered by shippers to Manila or Cebu provide the shortest alternative trading routes for perishable crops using cold chain technology.

In order to ensure success of these pilot cold chain projects, other government interventions include production support services, marketing assistance services, organizational strengthening, capacity building in vegetable production and postharvest care through training, and other postharvest handling services.

Three pilot cold chain projects are at different stages of development. All of the required equipment and facilities, including refrigerated trucks, and vans and a cold storage facility are in place for the Benguet to Manila trade route. The project is now currently laying the groundwork for the actual operation of the cold chain system. Installation of the cold storage facility in the second trade route has been completed, while in the third trade route, all of the components of the cold chain with the exception of the pre-cooler system are in place.

Interventions to improve the postharvest handling of semi-temperate vegetables are also being conducted. There is now a gradual shift in transport packaging from the crude but inexpensive bamboo baskets, wooden crates, sacks, etc. to the use of collapsible plastic crates which although more expensive offer improved protection to the high value vegetables during transportation. With improved organization among small vegetable growers, increased marketing to institutional buyers, and increasing incomes, small farmers have become more receptive to implementing innovations in postharvest handling and processing.

PROBLEMS AND CONSTRAINTS TO THE REDUCTION OF POSTHARVEST LOSSES IN VEGETABLES AND REMEDIAL MEASURES TAKEN

The country's vegetable industry is still beset with numerous and complicated problems relating to production, postharvest handling, marketing, credit and financing, and institutional and policy support systems. However, this paper only focuses on the discussion of national-level issues and problems pertaining to the reduction of postharvest vegetable losses and the suggested measures to address them. Among the more critical of these are:

Inefficient Marketing Systems

The local vegetable industry is hampered by the lack of an effective marketing system. Marketing channels lack organization and the large number of middlemen results in produce going through a series of handlers with varied skills and knowledge of proper postharvest handling. Excessive handling through the market chain results in high losses. The multi-layered marketing channels also result in considerable disparities between farm gate and retail prices to the disadvantage of consumers, while not necessarily translating to higher incomes for producers. The consequences of these inefficiencies in marketing systems are low returns on produce, which serve as a disincentive to the improvement of postharvest technologies.

The organization of producers into commodity clusters would greatly increase efficiency in marketing systems and in linking farmers to markets. Clusters consisting of 5 to 10 growers, would, for example facilitate production programming, and improvements in product quality. Clustering would also allow farming groups to focus on the production of a specific vegetable. Small clusters stimulate innovation and more importantly promote sharing of information and experiences. In times when growers experience crop damage and reduced harvest, a grower's supply deficiency can be matched with another's surplus production so as to stabilize the volume of supply to the cluster's contracted market. Clusters can also provide an effective vehicle for the transfer of postharvest technologies, as well as an entry point for government interventions. Clustering as part of a production and marketing strategy has proven to be successful in the country, as will be reviewed later in this document.

Poor Market Infrastructural Support

Much of the postharvest loss in vegetables is sustained during transportation, owing to the poor condition of farm-to-market roads, and during storage owing to limited knowledge of the proper operation of cold storage facilities. There is also a lack of cold storage facilities for use by producers during the vegetable supply glut. Existing cold storage units in certain areas are often not suited to the storage requirements of vegetables produced. Often, available cold storage is inappropriate for the storage of leafy and fruit vegetable types, which have relatively high relative humidity requirements.

In addressing the poor conditions of farm-to-market roads, both the DA and the Department of Public Works and Highways (DPWH) should rationalize funding allocations by giving priority not only to areas which produce staple crops, such as rice and corn, but also to vegetable production areas, especially in the CAR where 80% of the national supply of vegetables is produced. Landslides along the transport route are a common occurrence in the CAR, particularly when strong typhoons or heavy rains strike the area. Such conditions often immobilize vegetable transporters for extensive periods (days), and result in wastage of several tons of vegetables bound for demand areas in Manila and other provinces. Despite this alarming situation, funding support from the government seems slow in coming as viewed by local government officials.

Refrigerated storage designed for vegetables should be established in strategic areas, so as to preserve and prolong the shelf life of vegetables. Training on the correct operation and maintenance of these facilities should be part of the supply package.

Lack of Grading Systems and Standards

Vegetables, in particular those destined for sale in traditional markets, are neither sorted nor graded. Physical and quality losses are incurred owing to mechanical damage and to contamination of good quality produce by physically damaged and poor quality produce. Grading systems for vegetables are generally far from satisfactory, and are usually based on subjective personal judgment. This subjective evaluation includes consideration for physical attributes of the produce such as size, quality, and variety, rather than well-defined and highly acceptable standards. Market players are often reliant on specifications set by buyers. Thus, there is a need to establish grades and standards for vegetables that are acceptable to all stakeholders of the vegetable industry. The Bureau of Agricultural and Fishery Products Standard (BAFPS), the agency of the DA which is mandated to develop standards, should be provided with the required funding and personnel to implement its mandate. Strict enforcement and implementation of standards developed is equally important.

Ineffective and Inadequate Research, Training and Extension

The transfer of available technologies on postharvest handling, storage and processing is sporadic and ineffective. This could be attributed to the fact that government and extension personnel are trained in postharvest technologies for corn and rice, but not for vegetables. Moreover, relatively limited funding is provided by the Government for research, training and extension. There is therefore a need for Government intervention to facilitate the development of location-specific, cost effective postharvest technologies which enhance productivity within the vegetable sector. Results of such research, together with the existing knowledge base, should be documented, disseminated and promoted among small vegetable growers. This will, however, necessitate strengthening the capacity of extension personnel of local government units to enable them to better promote postharvest technologies and to guide the vegetable growers to follow proper postharvest handling practices.

Lack of an Integrated Program for Improving Vegetable Postharvest Handling and Marketing Systems

The vegetable postharvest and marketing system includes operations such as grading, packaging, transportation, wholesaling and retailing. Additional operations that might be included in the system are trimming, pre-cooling, storage, disease and insect control treatments, as well as prepackaging. Improvement at only one point of the marketing chain to preserve produce quality may be futile when the other points may serve as bottlenecks. A systems approach or an integrated improvement program covering all postharvest operations and procedures is necessary to guarantee success. For instance, if two operations in the postharvest handling system need to be improved, all other elements of the chain must be simultaneously improved. Improvement of only one operation may prove ineffective.

POSTHARVEST MANAGEMENT TO REDUCE LOSSES: TWO SUCCESSFUL CASES

Tramline System for Hauling of Highland Vegetables

Vegetables are grown on the terraces of mountain slopes at altitudes of about 2,000 m above sea level in elevated areas in the CAR. These areas, which are often isolated by ravines, are usually 0.3 km to 1 km off the road and are accessible only by foot trail. Manual hauling is the only means of transporting harvested vegetables from the gardens to the road for transportation to trading centers. The cost of manual hauling is high, owing to the long time spent transporting harvested vegetables to the road side through the foot trails. Postharvest losses incurred in the process are high. Wilting and mechanical damage due to puncture, bruising, or abrasion is the major cause of losses during manual hauling. Losses on account of delays in transporting the vegetables and mechanical damage due to slipping of haulers while traversing steep and rugged slopes can reach as high as 5%.

In order to address the problems caused by manual hauling of vegetables, the BPRE in collaboration with the DA's regional field unit in CAR introduced the use of a tramline system to a group of vegetable growers in the municipality of Atok, Benguet Province. The objective of the pilot project was to determine technical requirements and to evaluate the socio-economic implications of a mono cable tramline as a hauling facility for farm inputs and for the delivery of the produce outputs of vegetable growers. Further to the establishment of the tramline facility, vegetable farmers, who organized themselves into an association, were trained in the operation, safety and management of the facility, in value orientation, leadership, and in simple bookkeeping and accounting. Results gathered during one year of monitoring the facility showed the following technical and socio-economic developments:

- A significant reduction in the time requirement for hauling produce (a reduction of 17 man-days per hectare);
- Reduced handling losses owing to the increased efficiency with which the harvested vegetables could be move from the gardens to the road. With the tramline facility, on farm handling losses were minimized to a mere 1%;
- The hauling of farm inputs such as fertilizers was facilitated with the tramline facility, which allowed growers to follow the recommended rates of applying fertilizers in their vegetable farming, and consequently increased their yields;
- The socio-economic impact of the hauling innovation were: a) ease of the drudgery associated with manual hauling down the steep slopes, b) savings on time which allowed attention to be paid to other household activities, c) reduced production cost and improved farmer income, and d) increased productivity;
- The tramline was environmentally friendly in that it did not change the landscape environment.

With the above-described benefits accruing to the vegetable growers in highland areas such as in CAR, the tramline system is now being aggressively promoted by BPRE in other areas of the Philippines for the purpose of hauling both fruits and vegetables.

Penetrating Institutional Vegetable Markets through Clustering and Application of the Cold Chain System

This case illustrates how small vegetable growers can work together to penetrate good markets, e.g., supplying institutional buyers including fast food processors, hotels, restaurants, and supermarkets.

On the island of Mindanao, small vegetable growers in different villages of the highland province of Bukidnon have begun producing vegetables such as lettuce, carrots and garden peas for local traders at the vegetable trading post at CDO, which is situated 75 km away from the farms. Green Haven Farm produces approximately 100 kg of lettuce on a weekly basis. Selling lettuce to the local traders was difficult, since they purchased at low prices and deducted 25% from the weight as an allowance for trimmings, despite the fact that the lettuce was of good quality. An alternative market was sought by the grower who began supplying 200 kg of lettuce on a weekly basis to fast food outlets in the neighboring island of Cebu, the country’s second highest demand center after Manila. This lettuce was transported by boat.

A year later, an additional market (a vegetable processor supplying large fast food outlets in the metropolis) was identified in Manila, and approximately 400 kg of lettuce were transported by air on a weekly basis. Apart from the high cost of airfreight, lettuce delivered to the processor did not meet the 61% yield specified in the marketing contract, owing to the need for 16 to 20% trimming. Attaining the high quality standards of the fast food processor was a formidable challenge to the grower. However, given the grower’s determination to succeed in the farm enterprise and the processor’s recognition of this willingness, recommendations pertinent to the use of refrigeration and shipping were made by the processor, in order to reduce freight cost. The processor, in addition, readily offered technical advice on the improvement of production and postharvest practices to the grower. A further problem nevertheless encountered by the producer, was that of supplying a 20-foot refrigerated van with 3.5 Mt of lettuce on a weekly basis. The solution was to convince other lettuce growers in the area to form a cluster of growers. This cluster of growers, called the lettuce cluster shared production technologies to come up with a common quality standard. By the middle of 2002, the first reefer van load of lettuce was shipped to the processor in Manila, and the cluster had been consistently delivering required volumes of lettuce on a weekly basis. With the use of refrigerated transportation, the trimmings were significantly reduced to a maximum of 10% and the processor’s yield recovery specification of 61% was successfully met.

In an effort to further improve the lettuce supply chain, BPRE in collaboration with other government agencies under the DA’s national cold chain program has provided assistance to the cluster in terms of equipment support. A ten-foot refrigerated truck, a 20-foot refrigerated van, and a pre-cooler, which is currently being tested for its technical performance, comprised the equipment package. These components are required to complete the cold chain system for the cluster.

Current postharvest handling practices of the lettuce cluster are illustrated in Figure 1. Lettuce is transported to the packinghouse immediately after harvest for cleaning, sorting and air drying. It is cleaned by wiping with a cloth to remove soil and other dirt particles, following which it is air dried to remove surface moisture which causes rotting and spoilage. Depending on ambient temperature and relative humidity conditions, air-drying takes at least two hours. Citrus (calamansi) juice, alum, or ascorbic acid is applied to the cut portion of the lettuce to prevent browning. Lettuce heads are carefully arranged into nestable plastic crates with a brown paper lining for every two layers of lettuce. Each layer consists of 12 lettuce heads. Vents within the crates help to maintain vegetable quality in transit. Crates used for transportation are rented from the San Miguel Corporation, a premier food company in the country. Each crate can accommodate about 11.5 kg of lettuce. After packaging, cluster growers transport their produce on an individual basis, to a consolidation area in Impasugong in Bukidnon. Farms that are farthest away from the consolidation area are given priority in using the refrigerated truck provided by BPRE. The crates of lettuce loaded into a 20-foot refrigerated van rented from a service provider called Cryo. The refrigerated van is then transported to the CDO pier for loading into the ship en route to Manila. Shipping time from the consolidation area up to the buyer/processor usually takes 40 hours.

The achievements of the lettuce cluster of five growers to date, has far provided the impetus for other independent, small lettuce growers to join in the cluster. This development has given the cluster a window of opportunity to expand its production volume and, in turn its captive market.

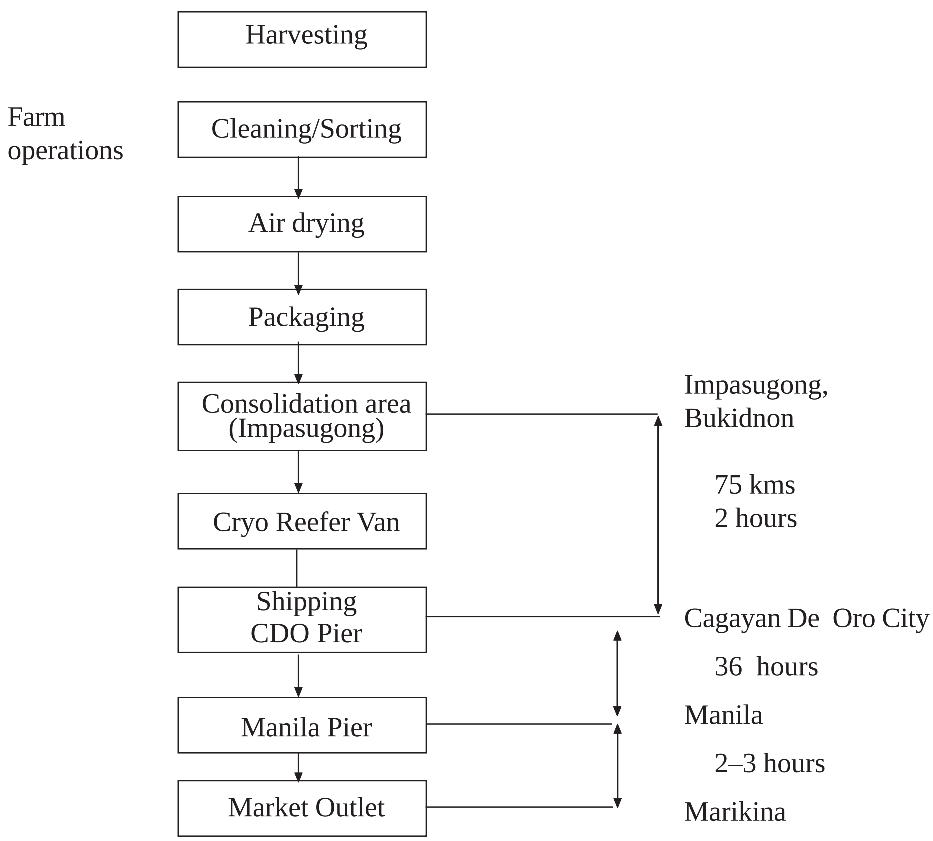

Figure 1. Postharvest Handling Practices of Lettuce Cluster

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19. SINGAPORE

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INTRODUCTION

Singapore is an island state located in South-East Asia with a land area of 680 sq km and a population of around 4 million. Over the years, land allocated for agricultural development has declined tremendously owing to land use demand for residential, manufacturing and infrastructural development. Despite limited land availability, the government has allocated 1,500 hectares (or 2.5% of the total land mass) of land for the development of agro technology parks for agriculture. These agro technology parks are dedicated to intensive, technology-based farming. Vegetables, orchids, ornamental plants, fish and poultry are produced on these farms. In 2003, there were 61 vegetable farms occupying 106 hectares of land and 2 fruit farms covering 7 hectares.

Approximately 16,563 tonnes of vegetables, mainly leafy vegetables and bean sprouts were produced on the vegetable farms in 2003. These vegetables accounted for approximately 5% of the total vegetable consumption requirements in Singapore. The remaining 95% of Singapore's vegetable requirements are met by imports from Malaysia, Indonesia, Thailand, China and Australia, while fruits are imported from Malaysia, Thailand, China, Australia and the United States. Fruit-vegetables or fresh produce such as broccoli, tomatoes, sweet chilli and sweet potato are imported from China, Thailand and Vietnam.

POSTHARVEST HANDLING ON LOCAL FARMS

Intensive cultivation is practised in Singapore, with between 8 and 9 cycles of a single crop grown on the same plot of land annually. Fast-growing leafy vegetables, having a growth cycle of between 21 and 30 days from seed to harvest are produced. More than 80% of the leafy vegetables produced are cultivated in soil, while the remainder are produced using hydroponic cultivation. Leafy vegetables are either produced in netted houses or in growing houses with polyvinyl chloride (PVC) roofs (protected cultivation), equipped with semi-automated irrigation systems.

At least 75% of the vegetables cultivated in Singapore are leafy vegetables. These include caixin (*Brassica chinensis*, parachinensis), baicai (*Brassica chinensis*), xiaobaicai (*Brassica chinensis*), leaf mustard (*Brassica juncea*), Chinese cabbage (*Brassica campestris*), Gailan (*Brassica alboglabra*), bayam (*Amaranthus gangeticus*), lettuce (*Latuca sativa*) and Ceylon spinach (*Basella rubra*).

Vegetables are generally harvested in the late afternoon, although in some cases, they are harvested in the morning. Leafy vegetables are cut at the stem from the growing beds by hand using a knife, following which they are trimmed and packed directly into plastic crates lined with newspaper. This produce is temporarily placed under shade provided by a beach umbrella in the field. To avoid accumulation of heat due to the hot weather in Singapore, farmers are advised to transport the vegetables to a proper shed or pre-cooling room within half an hour of harvesting.

Vegetables sold in bulk are cut, sorted, trimmed and packed in plastic crates in the field, after harvest. These operations are carried out under a beach umbrella in order to avoid direct sunlight and to reduce moisture loss. The produce is subsequently transported to a shed for holding, prior to either direct delivery or delivery by middlemen, to retail markets or wet markets. Vegetables sold in bulk generally do not undergo either pre-cooling or cold storage. Cold rooms are used on a few farms for vegetable storage, prior to delivery. All vegetables harvested on local farms are sold to consumers especially housewives by the following day. The vegetables are usually kept in a home refrigerator for 4–5 days prior to undergoing yellow discoloration.

Vegetables sold in unitized packaging are packed in packing houses at the farm level. The harvested vegetables are packed in PVC crates, pre-cooled for either a few hours or overnight in a cold room maintained at 3–5°C, prior to processing and packaging. Vegetables are packaged in units of either 200 g or 400 g and packaging is carried out in a packing house maintained at 18–20°C. Retail packaged vegetables are generally supplied to supermarkets.

POSTHARVEST HANDLING OF IMPORTED FRUITS AND VEGETABLES

Leafy vegetables are highly perishable and are imported from neighboring countries such as Malaysia and Indonesia. Vegetable imports from Malaysia are either packed in bamboo baskets, paper boxes or PVC crates, and are transported to Singapore by truck under ambient conditions, to the Singapore Vegetable Wholesale Center. Vegetables arrive either during the morning from the Cameron Highlands (Malaysia) or in the afternoon from southern Malaysia. The fruits and vegetables are auctioned and sold to retailers upon arrival. Prices vary according to the quality. The best prices are obtained during the festive season. The relatively small quantities of produce that are not sold are retained in cold rooms by the wholesaler.

Leafy vegetables imported from Indonesia are packaged for retail sale and are transported via a cold chain. Vegetables are pre-cooled for a few hours to remove field heat prior to retail packaging. The retail packaged vegetables are transferred to paper boxes and stored in cold rooms either for a few hours or overnight. The boxes of vegetables are transferred from cold storage via a refrigerated truck to a refrigerated boat for shipment to Singapore. Vegetables imported from Indonesia generally have a shorter shelf life than those produced locally or imported from Malaysia, primarily due to the distance and time required for transportation.

Almost all of the fruit and vegetable imports from China, Thailand, Australia and Vietnam are transported in refrigerated containers (40 ft) via a cold chain. Fruit-vegetables and high value leafy vegetables are packed in poly-styrofoam boxes after pre-cooling. They are shipped over 3 to 5 days, depending on their origin. Leafy vegetables imported from these countries generally have a shelf life of only 3–4 days. On arrival in Singapore, fruit are partially ripened. Batches of fruits are ripened by covering and storage in a box for generation of heat for ripening. High value imported perishable fruits such as strawberries are generally transported via a cold chain system to extend their shelf life.

Postharvest losses in fruits and vegetables average around 10 to 20% depending on the type of fruit or vegetable.

MARKETING

Farmers in Singapore can either sell their produce through middlemen or directly to retail markets. Current trends show growth in direct marketing and less reliance on middlemen. A survey conducted in March 2003 revealed that 43% of farms sell their produce directly, while 41% were dependent on middlemen to market their produce, while a similar survey conducted in 1997, revealed that 60% of produce was marketed through middlemen and 22.5% was directly marketed.

In recent years, supermarket demands for retail packaged vegetables have shown a growing trend. Vegetables for retail packaging are prepared by a few vegetable farms, for supply to supermarkets. With urbanization and an ever-increasing number of working couples, there is a growing need for consumers to purchase fresh produce after office hours, thus the growth in supermarket sales of these items. Vegetables displayed in supermarkets are kept either at refrigerated temperatures of 8–15°C or in air-conditioned rooms maintained at 25°C.

Vegetables sold in traditional wet-markets are either pre-packed or displayed in bulk, for selection by consumers. Vegetables are kept at ambient temperatures without refrigeration in traditional wet markets.

Safety Issues Associated with Marketing

Farmer earnings are dependent on middlemen who usually select the best price depending on demand and who usually earn a larger share in commission from retailers and distributors. Farmers do not see the need and do not have the financial ability to improve their farming techniques and to refrigerate their produce or store it in a chill room after harvest as the retail prices for their produce are low (Table 1). Vegetables consequently have a shelf life of only 4 days. Cold chain management of fruits and vegetables from farm to fork is not fully established in Singapore. Some farmers or market retailers consider the cold chain too costly and not economically beneficial to them.

Table 1. Retail Prices for Vegetables

Vegetables ($/kg)	2000	2001	2002	2003	2004
Cabbage	1.71	1.63	1.56	1.59	1.50
Spinach (bayam)	2.11	2.03	2.03	1.97	1.96
Small Mustard	2.26	2.16	2.33	2.15	2.22
Kale	3.12	3.04	3.15	2.96	2.90
Long Beans	2.74	2.74	2.85	2.74	2.66
Tomatoes	2.56	2.42	2.47	2.20	2.10
Garlics	2.75	2.63	2.52	2.35	2.63
Carrots	1.97	1.96	1.87	1.83	1.72
Potatoes	1.18	1.14	1.16	1.18	1.23

Source: All retail prices are extracted from Monthly Digest of Statistics.

Apart from lacking financial means, most farmers are uneducated and are not well trained in the pre- and post-harvest handling of fruits and vegetables.

A number of other farms scattered across Singapore adopt different cultures and practices. The lack of a unified association amongst fruit and vegetable farmers to gather and share information and discuss issues makes it difficult for the government to focus and implement changes in the farming community.

SAFETY OF FRUITS AND VEGETABLES

As of date, no specific ban exists on local and imported fruits and vegetables and no cases of food poisoning arising out of imported fresh fruits and vegetables have been reported. Singapore enjoys one of the lowest incidences of food-borne disease outbreaks compared to the rest of the world, with 1,256 cases reported in 2001 despite its heavy dependence on food imports. This high level of food safety is due to the vigilance of the Agri-food and Veterinary Authority of Singapore (AVA). Singapore adheres to the food safety standards set by the Codex Alimentarius Commission. The country adheres to the legally permitted levels of maximum residue limits (MRLs) in its regulation of pesticide levels, microbiological standards (counts), maximum limits of heavy metals (Arsenic, Lead and Copper) and maximum limits of chemical preservatives such as sulphur dioxide recommended by Codex for use in or on fruits and vegetables. All of these are stated in the Food Regulations of Singapore (The Sale of Food Act). These limits take into consideration the levels of contaminants in fruits and vegetables that can be consumed daily over a lifetime without appreciable health risk to the consumer. These limits also have a built in safety factor to account for differences in sensitivity. The AVA has also put in place an effective integrated food safety system to ensure that both locally produced and imported fruits and vegetables are safe at source. It has also implemented food safety assurance schemes and programs.

Integrated Food Safety Systems

An integrated food safety system, integrates careful food sourcing, the tagging of consignments of produce in order to trace sources, inspection, laboratory testing, surveillance of high-risk produce based on history of violation of safety standards and industry regulations that help tighten the food safety net. The AVA has imposed very stringent rules and conditions on the import and transshipment of fresh fruits and vegetable. In order to deter illegal and non-conforming imports, ad-hoc surprise checks are carried out at checkpoints and Lorries carrying fresh fruits and vegetables by road are required to call at the Singapore Vegetable Wholesale Center for 100% checks. The trade documentation and import inspection figures for 2003 are shown in Table 2. Fruit and vegetable imports into Singapore must comply with safety requirements as stated in the Control of Plants Act. For instance, importers are required to submit a phytosanitary certificate with additional certification on freedom of regulated pests. They must also pass a post-entry inspection at premises pre-approved by the AVA. A 3-month suspension of the imports of specific vegetables and fruits will be imposed on importers whose produce repeatedly fails laboratory tests. In addition, any person without a licence and permit is prohibited from importing and transshipping fresh fruits and vegetables. Any person who contravenes the regulatory requirement under the Act shall be guilty of an offence and shall be liable on conviction to a fine not exceeding SGD10,000 or to imprisonment for a term not exceeding 3 years or to both.

Under the inspection for imported fruits and vegetables, the AVA under its food safety surveillance and monitoring programs, imposes a basket tagging system to identify supply sources and to monitor the performance of their products. The AVA conducts inspections of these import consignments at the point of entry into Singapore to ensure that they are free from disease and spoilage. Samples of imported fruits and vegetables from all countries are randomly selected, and suspicious samples are sent for laboratory analysis, which includes testing for sulphur dioxide residues, microorganisms (*E.coli* 0157:H7, Salmonella), heavy metals, pesticide residues and parasites. These analyses are done by the AVA's Veterinary

Public Health Laboratory which harness the latest technology to achieve the highest expertise, technical standards, efficiency and quality assurance and has successfully attained accreditation under the Singapore Accreditation Council-Singapore Laboratory Accreditation Scheme (SAC-SINGLAS) and Plant Health Laboratory. These analyses generally take about one day. Consignments which fail these tests are rejected and destroyed or returned to the country of origin under the supervision of the AVA.

These surveillance programs play a pivotal role in enabling the AVA to maintain a database for monitoring the safety of food originating from the various sources. Fruits and vegetables that are known to be problematic are subject to stricter checks and controls (Table 3) under the Enhanced Enforcement Inspection Program. Currently, 18 types of vegetables (Bayam, Caixin, Capsicum, Chilli, Chinese Celery, Coriander, French bean, Garland Chrysanthemum, Kale, Kangkong, Leaf Mustard, long Bean, Mint Leaf, parsley, Spinach, Spring Onion, Tomato and Xiao Baicai) are included in this database.

Table 2. Trade Documentation and Import Inspection Figures (2003)

	Meat and Meat Products	Fish and Fish Products	Fruits and Vegetables	Processed Food
No. of traders registered	2,264		945	5,120
No. of import permits issued	18,768	174,579	195,607	267,540
Quantity and value of products approved for import (tonnes/mil $)	208,679 659	222,876 1,056	819,094 702	2,826,729 4,803
No. of consignments inspected	53,286	2,242	10,380	16,206
Quantity and value of imported products inspected (tonnes/mil $)	208,285 652	5,484 30	15,383 22	625,457 960
No. of consignments rejected	417	13	186	35
Quantity and value of consignments rejected (tonnes/mil $)	4,709 9.75	26 0.08	145 0.227	39.8 0.06

Source: AVA Annual Report 2003/04

Table 3. Food Items under Intensive Checks

SN	Type of Product	Type of Test/Requirements
1	Preserved vegetables (pickles)	Test for sulphur dioxide, sorbic acid, benzoic acid and artificial sweeteners
2	Maize & corn	Test for aflatoxin
3	Preserved Fruits	Test for artificial sweeteners, sulphur dioxide, benzoic acid, sorbic acid, methyl or propylparahydroxy benzoate
4	Coconut milk, shelled coconut, grated coconut, desiccated coconut	Microbiological Tests: ▪ Total colony count ▪ Total coliforms ▪ Faecal coliforms ▪ E-coli ▪ Salmonella ▪ Staph enterotoxins Chemical Tests: ▪ Sulphur dioxide ▪ Benzoic acid ▪ Sorbic acid

(To be continued)

5	Minimally processed cut/peeled fruits & vegetables	Microbiological Tests: ▪Total colony count ▪Faecal coliforms ▪E-coli Pesticide Residues Tests: ▪Dithiocarbamates ▪Organophosphate ▪Organochlorine ▪Pyrethroid ▪N-methylcarbanates

Local vegetable farms are also regulated by the AVA to ensure proper pesticide application. Vegetables that are ready for harvest are also sampled for laboratory testing to assure their conformance with standards.

In addition to existing routine surveillance programs, the AVA continually includes new programs or intensifies checks as and when needed.

Food Safety Assurance Schemes

Food safety assurance schemes have been put in place to reduce the risk of contamination at the point of food production. The Good Agricultural Practice (GAP-VF) Certification Scheme was introduced to vegetable farmers by the AVA. This scheme which was developed in order to align Singapore with international guidelines, seeks to establish a national benchmark for the production of safe and good quality local vegetables by promoting a safety assurance system at source. It also inculcates a sense of responsibility amongst local vegetable farmers for ensuring the production of safe vegetables of good quality for consumers in Singapore. This scheme also provides a product differentiation mechanism for local consumers who wish to purchase GAP-VF certified vegetables. Thus the scheme benefits the farmers mainly in marketing their produce, retailers in meeting increasing consumer demand for safe vegetables and consumers in enjoying the quality and safe vegetables.

Food Safety Awareness Programs

A number of food safety awareness programs exist in Singapore. These include programs such as “Keeping Fruits and Vegetables Safe”, “Tips on Choosing, Storing and Cleaning Fruits and Vegetables”, “Frequently Asked Questions (FAQ) on Fruits and Vegetables” and “The Cold Chain System.” Food safety campaigns designed to educate the public, are also held in Singapore.

The AVA also promotes food safety by grading the fruit and vegetable service industry. The food factory grading system categorizes food factories into either of four grades: A, B, C and D. This grading system is based on their food hygiene and food safety standards. Its objective is to raise the food manufacturers’ awareness of hygiene and food safety standards and the need for improvement. It helps to create higher standards among food manufacturers and the desire to improve by striving to obtain higher grades. The AVA also rewards farmers and importers under the Food Safety Partnership Award Scheme in an effort to spur the food industry to achieve higher food safety standards in their operations and to adopt a more proactive approach to consumer education on food safety.

No system is foolproof without the collaboration of the industry and consumers. The assurance of food safety cannot rest with the government alone. The AVA engages in constant dialogue with manufacturers, importers and consumers in Singapore to ensure that food standards comply with internationally accepted standards.

RESEARCH AND TRAINING IN POSTHARVEST TECHNOLOGY

The AVA includes a Postharvest Technology Division and a Horticulture Branch who work together with the Food Control Department as well as the Food & Veterinary Administration to improve the marketing and safety of fruits and vegetables in Singapore. The Postharvest Technology Division and Horticulture Branch conduct research and development on pre- and post-harvest technologies for fruits and vegetables. Research is conducted on pre-cooling, packaging, shelf life extension and quality assessment of fruits and vegetables, including sensory evaluation. Recent studies have also focused on the cold chain system, the development of guidelines for good postharvest processes and quality parameters for leafy vegetables, modified atmosphere packaging and fresh-cut vegetables.

Postharvest technology and knowledge is then transferred to local farms during regular farm extension visits or through seminars and technical bulletins. In addition, training courses are conducted for vegetable farmers as well as wholesalers, retailers and distributors.

CONCLUSION

Training courses, whether local or international, as well as seminars, would be beneficial to government officers. Local seminars designed to educate the public (including students, housewives), industry players, farmers and retailers are also useful. In addition, the invitation of foreign experts to Singapore to train industry players and farmers on postharvest management has also been found to be helpful.

Public education helps raise consumer awareness on the importance of safety in vegetables and fruits. Furthermore, each individual can play a part in raising awareness on food safety by inculcating good handling practices in keeping fruits and vegetables safe and by word of mouth especially among housewives.

The growing trend toward retail packaging and consumer demand for fresh cut fruits and vegetables necessitates the development of relatively new postharvest processing to ensure that fresh cut produce is fresh, of good quality and is safe for consumption. It will be equally important to minimize losses so as to optimize commercial gains for the industry.

A committee or association for fruit and vegetable farmers and industry players can be a great help whereby issues and problems can be discussed as a whole and practices and technology can be shared among the farmers and traders to develop the fruit and vegetable industry. This committee should collaborate with the Government and solicit its assistance and advice for greater achievement.

Every individual must play a role in raising awareness on food safety, in order to make Singapore a better place to live in.

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20. SRI LANKA (1)

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INTRODUCTION

Sri Lanka is traditionally an agro-based country. Its population of 19.25 million occupies 65,610 square kilometers of land. Temperatures in lowland areas average around 27.5°C, while in the highlands, they average at 17.5°C. Sri Lanka is divided into three broad climatic zones, namely, the wet zone, the dry zone and the intermediate zone.

The seasonality of rainfall in Sri Lanka results in two distinct cropping seasons: the Maha season (northeast monsoon) and the Yala season (southwest monsoon). Crop production, is highly seasonal in Sri Lanka, owing primarily to the climatic patterns and to the genetic make up of the crops produced. The vegetable subsector is the most important subsector after the rice sub-sector. Vegetables are produced on a year-round basis and a large number of farmers are engaged in vegetable production. Many of the farmers in the hill country derive their primary income from vegetable farming. Vegetable production on paddy fields in urban areas has increased in recent times.

The major season of fruit production is between April and September, while the minor season occurs between December and February. Fruit prices therefore fluctuate along with seasonality, wherein prices of fruits drop drastically during periods of glut and increase during the "off season."

Overall vegetable production increased by 2% to 552,000 metric tons in 2003. The annual production of some important fruits and vegetables during 2003 is shown in Table 1. Both low country vegetables and up country vegetables reported production increases. The area under vegetable cultivation increased by about 3% during that year, owing to the combined effect of a 6% increase in production during the 2002/03 Maha season and a 2% drop in the extent cultivated during the 2003 Yala season. Vegetable prices increased during that year despite the increase in the output of vegetables. A majority of the vegetables produced are consumed locally with exports amounting to less than 1% of domestic production.

Fruit production showed an overall increase in 2003. The production of bananas, mangoes and papaws increased, while pineapple production declined as compared to the previous year. Prices increased due to high demand, particularly from the recovering tourist sector. During 2003, Sri Lanka imported more than 52,600 metric tons of fresh and dried fruits, valued at LKR1.8 billion. Of the total volume of imports, apples accounted for 43%.

During 2003, more than 9.4 million kg of vegetables and 7.7 million kg of fresh and dried fruits, valued at LKR679 million and LKR605 million, respectively were exported. Although a large variety of fruits are being exported, few export oriented commercial cultivations exist in Sri Lanka. Cultivation in controlled environments, using tissue culture plants would help to increase the volume and quality of fruit and vegetable outputs in Sri Lanka.

Table 1. Fruit and Vegetable Production in Sri Lanka in 2003

Vegetables		
Crop	Extent (Ha)	Production (M.Tons)
Ladies Fingers	6,857	36,786
Brinjals	10,629	74,469
Better Gourd	3,960	20,119
Snake Gourd	2,881	18,184
Tomato	5,936	44,974
Cucumber	3,152	23,389
Leeks	1,537	22,420
Ash Pumpkin	954	7,320
Red Pumpkin	7,228	63,830
Ash plantain	11,259	72,937
Capsicum	2,815	12,499
Cabbage	3,718	52,222
Carrot	2,486	27,210
Knoh Kohl	1,395	14,240
Beet Root	1,721	15,574
Raddish	2,222	20,079
Beans	6,291	31,687
Total	75,041	557,939

Fruits		
Crop	Extent (Ha)	Production (000 Nos.)
Orange	3,936	25,274
Lime	9,696	169,568
Mango	28,627	500,577
Plantain (000 Bunches)	49,667	32,997
Papaw	4,653	29,641
Pineapple	4,825	40,716
Passion Fruit	326	5,334
Total	101,740	804,107

Primary Source: Dept. of Census & Statistics
Secondary Source: Data Bank of HARTI

POSTHARVEST LOSSES IN FRUITS AND VEGETABLES

Postharvest losses in some fruits and vegetables are the result of pre-harvest diseases and infection. Pod borer damage in brinjal (*Solanum melongena)*, anthracnose in beans (*Phaseolus vulgaris)*, soft rot in carrot (*Deucua carroka)* and fruit fly damage in cucurbits, all begin pre-harvest, if not properly controlled. Similarly, in the case of fruit, Anthronimus, fruit fly damage in mango (*Mangifera indica*), ring spot in papaya (*Carrica papaya)*, mealy bug damage in pineapple (*Ananas comosus)*, mosaic damage in passion fruit (*Passiflora edutis)* and ring spot damage in avocado (*Percia americana)* occur pre-harvest. Losses during transportation and storage are aggravated when vegetables are exposed to pest and disease attack pre-harvest. Pre-harvest care is therefore essential to reducing postharvest losses. Time of harvest is yet another important consideration which influences postharvest losses in both fruit and vegetables.

Postharvest losses significantly reduce the availability of produce in markets, and widen the price gap between the producer and consumer. Losses are generally higher in fruits than in vegetables. Results of an Island-wide survey conducted by the Institute of Postharvest Technology in the Year 2002 revealed postharvest losses in vegetables to vary between 16 and 41%. These losses were highest for cabbage and leeks and lowest for okra. In the case of fruits, postharvest losses varied between 30 and 40%. Postharvest losses at key steps of the marketing chain, for vegetables and fruits are presented in Tables 2a and 2b, respectively.

Table 2a. Average Levels of Postharvest Losses in Vegetables at Various Steps of the Marketing Chain

	Postharvest Loss (%)				
Crop	Grower	Collector	Wholesaler	Retailer	Total
Brinjal	10.99	8.96	2.22	10.75	34.76
Beet	7.21	9.12	2.13	8.56	27.02
Cabbage	8.36	13.11	6.17	13.23	40.87
Carrots	6.47	9.32	2.83	9.78	28.40
Leeks	9.77	14.47	5.2	11.44	40.88
Tomato	7.25	10.25	4.59	13.33	35.42
Beans	6.07	7.93	1.54	9.5	25.04
Bitter Gourd	5.13	5.13	1.86	10.25	22.37
Okra	4.5	4.55	2.38	4.64	16.02

Table 2b. Average Levels of Postharvest Losses in Fruits at Various Steps of the Chain

	Postharvest Loss (%)				
Crop	Grower	Collector	Wholesaler	Retailer	Total
Banana	5.27	7.58	3.25	14.13	30.23
Pineapple	7.21	8.53	2.89	12.53	31.16
Papaya	5.78	10.12	4.95	15.28	36.12

A major contributor to postharvest losses in the marketing chain of fruits and vegetables is the lack of knowledge.

CAUSES OF LOSSES

Causes of losses include:

Harvesting
- Harvesting at an incorrect stage of maturity
- Damage due to harvesting devices
- Exposure to sun
- Rough handling

Collection
- Exposure to sun
- Rough handling during loading and unloading
- Tight packing
- Compression damage during packing and stacking
- Damage due to vibration

Transportation
- Transportation in poly sack bags
- Tight packing and overloading
- Compression damage during stacking
- Vibration damage during transportation
- Heat build up during transportation
- Rough handling during loading and unloading

Retail sale
- Rough handling
- Exposure to sun and rain

Papayas and mangoes are usually harvested at immature stages of development, owing to difficulty in identifying the exact stages of maturity required for minimal injury during transport. Immature fruits do not ripen naturally and in cases where they do, are of extremely poor quality. Mangoes harvested at an immature stage, exude latex which results in skin burns and high postharvest losses. Mauritius pineapples are grown for consumption in the fresh form and are harvested immediately prior to color development. Higher acidity and lower sugar levels in fruit prior to color development, as compared to those harvested at 25% of shell color development, results in low quality of the ripened product.

Bananas are harvested at the mature green stage. The external appearance of the ripened bananas in retail markets is, however, extremely poor owing to excessive bruising and disease. Avocados are harvested using a partially improved picking pole with a net bag attached, in order to minimize injury during harvesting. Pulling of the fruit during harvest can, however, separate the fruit from the stock and result in mechanical injury. The majority of fruit so injured are attacked by stem end rot pathogens.

Harvesting of vegetables at an over mature stage is a common practice in Sri Lanka. Postharvest losses in okras, beans, long beans, and bottle gourds are extremely high owing to the toughening of texture. High temperatures in growing areas and temperature build up during transportation in polypropylene sacks, accelerates the toughening process.

Fruits and vegetables reach consumers primarily through collection agents, wholesalers and retailers. Rough handling during harvesting causes mechanical damage and poor packaging and distribution aggravates the problem. Vegetables are often tightly packed by forcing them into polypropylene sacks. These sacks provide relatively little ventilation and result in a temperature build up which accelerates both toughening and senescence. Laboratory studies have shown that mechanical damage in poly sacks results in cracks and cuts through which the vegetables lose moisture and become susceptible to microbial attack.

Once packed in poly sacks, the produce is kept at the roadside until picked up by collection agents. This interim period allows exposure to the hot sun and rain. Sacks are loaded with little care into trucks where considerable damage due to compression results in further significant losses.

Because of the high cost of transportation, wholesalers generally transport maximum quantities of produce without consideration for the likelihood of quality loss. Overpacking and poor ventilation in trucks causes temperature buildup, resulting in rapid quality deterioration. Deterioration is further accelerated by exposure to sun and rain. Rough loading and unloading of trucks takes place at the wholesale level.

Bananas Bananas are packed in trucks without using either cushions or linings. Trucks are overpacked and stacked with several layers of banana bunches, resulting in significant mechanical damage.

Papayas Papayas are harvested at the 100% green, but mature stage and are generally transported in trucks without any packaging. In situations where packaging is used, it generally constitutes tea chests which result in significant compression damage and bruising. High temperature buildup in the tea chest significantly reduces papaya quality. The net result is high postharvest loss.

Pineapples Pineapples are packed in trucks without any packaging. Compression damage due to over packing is a major cause of losses. In addition, the slanted cut end of the stock penetrates other fruits causing high levels of mechanical damage and resulting in very high losses.

Avocados Avocados are transported in poly sacks. The major cause of postharvest losses in avocados is stem end rot. Infections of the injured stem end are a common problem that leads to very high losses. High temperature and relative humidity develops in the poly sacks and provides the ideal conditions for rapid multiplication of pathogens.

Moisture loss in fruits and vegetables is a common problem during marketing. Exposure to sunlight when the fruits and vegetables are displayed in roadside stalls causes high moisture losses. Shriveling of fruits and vegetables reduces their attraction to the consumer.

Calcium carbide is used for the production of ethylene, an inducer of fruit ripening. Ethylene is widely used for the ripening of mangoes, papayas, durians and bananas. Traders however exceed the recommended level of 1g/kg of fruit. Methods used in the application of ethylene can cause health problems since pieces of calcium carbide can be found among the heaps of fruit. Chemical impurities such as arsenic and phosphorus hydrides present in carbide can also contaminate the fruit.

RECENT DEVELOPMENTS IN THE MANAGEMENT OF POSTHARVEST LOSSES IN FRUITS AND VEGETABLES IN SRI LANKA

Postharvest management must be applied at every step of the postharvest chain, if losses are to be controlled. The farmer's knowledge of pre-harvest practices is important in preventing damage due to pests and diseases. Fruits and vegetables should be handled with care from the time of harvest till they reach the consumer. Maturity at harvest is an important factor, which influences storage life.

Determination of maturity indices for each fruit and vegetable is important in enhancing the knowledge of growers through training and extension. Maturity indices for some fruits and vegetables, as determined by the Institute of Postharvest Technology (IPHT), Department of Agriculture (DOA) and the Industrial Technology Institute (ITI) in Sri Lanka are presented in Tables 3a and 3b.

Table 3a. Maturity Indices of Fruits Produced in Sri Lanka

Fruit	Maturity Index	Remarks
Mango	Shape of the fruit Fruit color Outer cover appearance Flow rate of milk in the fruit	Shoulders move up Changes from green to Yellow Gloss disappears Reduced
Papaw	Fruit color	33–35% Yellow
Butter Fruit	Fruit size Appearance of the fruit Color of the seeds and flesh Color of the fruit (For violet color variety)	Full in size Gloss disappears Seeds-brown, flesh-cream Become violet from upper end
Banana	Fruit shape	Lines around the fruit disappear and fruit becomes plump
Durion	Fruit smell	
Pineapple	Fruit color	25% Yellow

(To be continued)

Orange	Appearance of the fruit Fruit color Fruit size Amount of juice Outer cover thickness	Smooth appearance Light Yellow Full in size Increased Thickness decreased
Jack Fruit (Waraka)	Smell Sound of the fruit	
Guava	Fruit color	From dark green to light green
Passion Fruit	Ripeness	
Pomegranate	Fruit color Appearance of the outer cover	Yellow Features
Peach	Peel color on the cheeks Cheek and pulp firmness Blossom end firmness	
Kiwi fruit	Soluble solid content Flesh firmness	
Apple	Flesh firmness Skin Color	
Olive	Flesh firmness Fruit size	
Blueberry	Fruit color Sugar content	

Table 3b. Maturity Indices of Vegetables Produced in Sri Lanka

Vegetable	Maturity Index	Remarks
Potato	Thickness of the outer skin Condition of the vine	Should be thick Should be matured and die
Sweet potato	Starch content	Higher
Tomato	Color of the fruit Size	Mature green-light / Pink Fully developed
Garden pea/pea	Color of the pod Toughness of the seed coat Size of the pod	Dark green to light Green Coat become tougher Fully developed
Cow pea	Color of the fruit Tenderness of the fruit	Green Moderately tender
Common/French/ Kidney bean	Pod Size Seed size	Before the pods are fully grown Small seeds
Lima bean	Seed size Pod Size Color of the pod	Nearly fully grown Nearly fully grown Should be green/before begins to turn yellow

(To be continued)

Jack and sword bean	Pod Size	Half grown
Mung bean	Color of the pod Number of seeds in the pods	Brown 10–15 seeds
Cabbage	Size of the head Color of the pod Hardness of the head	Should be fully grown White/light green Hard
Cauliflower	Size of the head Condition of the head	Full size Before head becomes discolored
Broccoli	Diameter of the sprout	1–1$_{1/4}$ inches
Asparagus	Height of the spear	5–8 inches above ground
Celery	Size of the stalk	Standard size
Sweet corn	Size of the kernel	Larger/full size and Plumper-milky stage
Cucumber	Formation of the fruit Size and the color of the fruit	Well formed Medium size, dark green
Lettuce- Leaf lettuce Head lettuce	Tenderness of the leaves Flavor Firmness of the head	Should not be tough Should not be bitter Should not become very firm
Musk melon	Easiness of removing the melon from the stem Color of the skin	Stem separates from the melon, leaving a clean stem cavity Change from cucumber green to a mottled green and light yellow
Spinach	Number of leaves in the plant Plant size	5–7 fully matured leaves Medium size
Amaranthus spp	Number of days after planting	3–4 weeks
Mustard	Number of days after planting Plant size	25–30 days after sowing Tender tips should be 3–4 inches long
Onion	Percentage of tops falling	Warm weather – 5% Cooler weather – 50%
Pepper	Size of the fruit Firmness of the fruit Color of the fruit	Full size Become firm Before begin to turn Red/yellow
Beet	Size of the crop	
Water melon	Sound method/thumping Condition of the tendril Accompanying the fruit Change in color of the portion of the melon resting on the ground	Drying of the tendril Change from pale white to a creamy yellow
Egg plant	Size of the fruit Color of the fruit	1/3 grown Well colored

(To be continued)

Garlic	Condition of leaves	Discolored and wilted
Okra	Tenderness and the size of the pod	Young/tender pods
Soybean	Size of the seeds	Fully grown and before seeds get hatched
Pumpkin and Squash	Softness of the shell Size of the fruit	Should be soft Fruit should be immature
Leeks	Diameter of the cylinder Length of the white part	1–$1_{1/2}$ inches in diameter 6–8 inches long
Breadfruit	Appearance of white latex on the Fruit skin Flattening of fruit segments	

Use of proper harvesting equipment also reduces mechanical damage. Harvesting equipment developed by institutions in Sri Lanka has been introduced to growers. Fruits are best harvested during the early morning; between first light and 8.00 a.m. Fruits harvested at mid day or mid afternoon have poor keeping quality, owing to their high respiration rates. Mangoes should be harvested between 10.00 a.m. and 3.00 p.m. in order to reduce latex burn on the fruit. Washing after harvesting is important for the removal of field heat. Use of proper sorting and grading systems increases the shelf life of produce, as well as grower income.

The harvested crop should be taken to a shady place, sorted, graded and packed at a "Packaging Center." The packaging material should be strong enough to support the produce, but should be sufficiently ventilated. Polypropylene sacks are not recommended for use in packaging. Compression damage due to over packaging and vibration damage during transportation are the cause of serious losses.

The "Fresh Produce Concept" introduced by the Institute of Postharvest Technology is mainly focused on introducing maturity indices, time of harvest, sorting and grading of produce followed by suitable packaging material to reduce handling and transport losses in fruits and vegetables. The introduction of returnable and nestable plastic crates in postharvest handling will reduce postharvest losses in fruit and vegetables, particularly during transportation.

A study was conducted in order to compare transportation losses in fresh produce, using polypropylene sacks and plastic crates. The use of plastic crates was found to reduce mechanical damage and senescence of fruits and vegetables, thereby providing high quality fresh produce to the end user.

SALIENT APPROACHES AND TECHNOLOGIES BEING USED IN SRI LANKA TO REDUCE POSTHARVEST LOSSES IN FRUIT AND VEGETABLES

The program on reduction of postharvest losses of fruit and vegetables is a long-term one which includes consideration for pre-harvest practices. The Department of Agriculture plays major role in pre harvest practices. The introduction of germplasm of several fruit varieties and an intensive research program on varietal improvement and agronomic practices began in the early part of this decade. Through this program, varieties with physical and chemical properties that allow improved handling and keeping qualities of fruits and vegetables are being introduced. Reduced postharvest losses have been observed for fruits such as papayas and mangoes and vegetables such as tomatoes and okras. Maturity indices introduced for some crops have also reduced postharvest losses. Postharvest losses of okra declined from 46% in 1998 (Year-round production of vegetables and fruits in Sri Lanka, July 1998) to 16% in 2002 (IPHT).

Fresh produce continues respiring even after harvest. Procedures such as low temperature storage and/or modified atmosphere storage retard the process of senescence. Damaged and diseased commodities should be discarded and the produce should be appropriately packed prior to storage.

PROJECT PROPOSED TO INTRODUCE MODERN TECHNOLOGIES

A project proposal designed to upgrade technologies in the fruit and vegetable sector was developed by the Department of Agriculture. This project proposed to construct three packing houses in major vegetable growing areas, namely Nuwara Eliya, Welimada and Hanguranketha. These packing houses would include basic facilities for washing, sorting and grading. Nestable plastic crates designed to minimize damage during transportation, would replace packaging in polypropylene sacks. Two cold rooms would be constructed for the temporary cold storage of produce. Two trucks with horizontal dividers would also be purchased to minimize transport cost and to prevent transport delays.

It was felt that such investment would lead to the large scale export of vegetables. Facilities for pre-cooling would be constructed in the latter part of the project. Refrigerated trucks would be purchased to transport pre-cooled vegetables to the Colombo harbor. The three pack houses would be operated as model pack houses, to be duplicated by farmer organizations within the country. Operations of the packing house facility would be explained and training methods for improving technologies would be demonstrated.

Project Management

It was proposed that pack houses would be constructed at major fruit and vegetable production areas. Farmers would be trained to sort, grade, pack and stack produce in trucks. Farmers would sell their produce to traders by negotiating the price. The officer in charge of the pack house (a trained individual) would help to decide on the price through accessing a market information system. Excess produce would be transported to other pack houses using vehicles owned by pack houses, for a reasonable price. In situations of reduced demand by traders, produce could either be transported to other pack houses or could be temporarily maintained in cold storage until purchased. Plastic crates would be purchased for each pack house and a nominal fee would be charged for using crates and other pack house facilities.

With the adoption of improved handling practices, farmers would be in a position to export their vegetables. Export orders could be dealt with through internet facilities and through the collection of vegetables from the pack house. Pre-cooling facilities would be established and refrigerated trucks would be used to transport produce to the harbor for sea freight. Continuous supplies of vegetables would be obtained by parallel connection of pack houses. Based on computerized data, future production of vegetables could be planned in order to prevent over supply hence eliminating a decline in prices.

NATIONAL ISSUES AND PROBLEMS IN REDUCING POSTHARVEST LOSSES OF FRUIT AND VEGETABLES IN SRI LANKA

Currently, the main aim of the farmer is to increase the production of fruits and vegetables and to ensure the sale of these items. Relatively little consideration is given to the postharvest quality of these fresh produce items. A change in farmer attitude is important if produce quality is to be improved and losses minimized. Lack of knowledge and poor practices are major contributors to postharvest losses in the marketing chain of vegetables. Extension services are required to strengthen the capacity of growers, collectors, transporters, wholesalers and retailers, to change their attitudes and to improve the knowledge base on postharvest practices.

The low-income level of stakeholders poses a major hindrance to the improvement of postharvest technologies in Sri Lanka. Polypropylene sacks are the least expensive form of packaging material (USD0.2) available on the market, and damage fruits and vegetables at every stage of the marketing chain. Plastic crates which are more costly (USD4 to 6), can be used to reduce postharvest handling and transportation losses. While growers, collectors, transporters and wholesalers are willing to use plastic crates, they are unable to purchase them, owing to high cost. Comparative studies conducted by the IPHT revealed that transportation losses in fruit and vegetables were reduced from between 15 and 20% to between 3 and 6% with the use of plastic crates. The implementation of national level policies to distribute plastic crates at subsidized levels is important.

Infrastructural facilities such as proper packing houses, well designed trucks with cooling facilities and highways for transportation with minimal damage due to vibration are essential in reducing postharvest losses. Appropriate national policies designed to address these issues are required if postharvest losses are to be reduced.

The Export Development Board coordinates improvement of the national export of horticultural produce. The Board also assists exporters in accessing loans and in visiting foreign markets. Agriculture Enterprise Development, a foreign funded organization, currently assists growers in producing high quality fruits and vegetables.

RESEARCH ON POSTHARVEST TECHNOLOGY

Research on the postharvest technology of perishables is conducted in three institutions, namely the Institute of Postharvest Technology, the Department of Agriculture and the Industrial Technology Institute (ITI). This field of research is recent, when compared to other fields such as agronomy and breeding, etc. Researchers have, however, achieved significant progress. Determination of maturity indices for fruit and vegetable harvesting has been completed for the majority of crops of economic importance. Studies were conducted by harvesting at different stages of maturity with due consideration being given to the quality of the commodity. Research shows that fruit and vegetable quality can be improved through timely harvesting. Subjective and objective indices have been developed for a majority of fruit crops.

Since the high losses are due to the inadequate packaging, returnable and nestable plastic crates have been introduced through a horticultural development project. Research has indicated that these plastic crates can significantly reduce postharvest losses. This technology is readily adaptable in the supermarkets.

Research on storage techniques has also been applied to a number of fruits and vegetables. A low-cost modified atmosphere storage system using sealed polyethylene bags has been used to extend the storage life of bananas, beans, tomatoes and some leafy vegetables. Controlled atmosphere storage has also been used for the transportation of locally grown "Embul" bananas, and has shown promising results. Optimal low temperature storage conditions for extending the shelf life of many horticultural commodities has been worked out. Some of this information has already been transferred to exporters who distribute by sea freight.

The production of quality fruits and vegetables together with suitable postharvest handling packages has been investigated. Research on the reduction of postharvest rot due to latex burns in mangos has been completed.

Several new varieties of high yielding fruits, vegetables, leafy vegetables, root crops and condiments were released by the Department of Agriculture during the year 2003. Several training programs on protected agriculture and postharvest processing were also implemented.

The Institute of Postharvest Technology (IPHT) introduced plastic crates for transportation of fruits and vegetables from collectors in Keppetipola, Mahaweli system G and H to wholesale markets in Colombo and the Dedicated Economic Centre in Dambulla, under its "Fresh Produce Chain" project to reduce postharvest losses during transportation. Under this project 5,836 crates were purchased by collectors and several such chains are now operational. IPHT is conducting research to further develop postharvest handling. In addition, it carried out training programs in order to upgrade the knowledge of producers, processors, traders and extension officers in both the public and private sectors on postharvest loss prevention and in the development of value added agro-processing enterprises.

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21. SRI LANKA (2)

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INTRODUCTION

The Sri Lankan economy is primarily based on agriculture. The agricultural sector contributes approximately 18% to the GDP of the country. Approximately 72% of the 19.8 million Sri Lankan people live in rural areas and agriculture provides employment for approximately 40% of the work force.

Among the many food crops cultivated in Sri Lanka, rice is the main crop grown. Rice is the staple food of Sri Lankans and rice production provides a livelihood to more than 800,000 farm families. More than 30% of the total labor force is directly or indirectly involved in the rice sector.

The vegetable sub-sector is the second most prominent sub-sector within the agricultural sector, as vegetables are grown throughout the country. Large numbers of farmers are involved in vegetable cultivation. Vegetable cultivation can be broadly categorized as being either low country or up-country. Low country vegetables are generally cultivated under rainfed conditions on small plots of land or in home gardens using little input by way of fertilizer or pesticides. Those grown in paddy fields during Yala season are often produced under irrigated conditions. Low country vegetables include brinjals, okra, bitter gourd, snake gourd, long beans, leafy vegetables, luffa, drumstick and capsicum. Low country vegetables are harvested on a seasonal basis. Up country vegetables which include leeks, beans, cabbage, beet root and carrots are intensively cultivated under irrigated conditions at high altitudes. Many of these are temperate varieties. Cultivation is staggered and harvesting is carried out throughout the year. In recent times, there has been a growing trend in the capital intensive commercial cultivation of vegetables which fetch high returns.

Sri Lanka does not have well managed fruit orchards. Pineapples are generally cultivated as an inter-crop under coconut cultivation especially in the western province of the country. Only a few fruit varieties such as banana, pineapple, papaya, passion fruit and rambuttan are commercially cultivated. Other fruit varieties such as mango, wood apple, guava, pomegranate and avocado are supplied mainly from home gardens. The demand for local fruits such as bananas, mangoes, pineapples, and papayas, is met mainly through local production. The local demand for certain fruits such as apples, oranges, grapes and dates is met through imports.

During 2004, imports of fresh and dried fruits amounted to 24,000 metric tons, a decline of 26% as compared to 2003. A cess was imposed on imported fruits in order to stimulate the local fruit farming industry.

FRUIT AND VEGETABLE PRODUCTION

Vegetable Production

Tables 1 and 2 show the annual production of major up-country and low country vegetables in Sri Lanka. According to available statistics, overall vegetable production was 552,000 metric tons in 2003. Vegetable production in both yala and maha seasons in the year 2004 increased. Production of both up-country and low country vegetables rose during the year 2004 (Annual Report, 2004). Almost all of Sri Lanka's vegetable production is consumed domestically and only one percent of the total production of vegetables is exported.

Table 1. Production of Up-country Vegetables in Sri Lanka (Mt)

Year	Cabbage	Tomato	Beans	Carrot	Radish	Leeks	Beetroot	Knoh-khol
1994	34,781	31,746	26,158	23,415	19,929	15,590	14,649	11,986
1995	34,836	31,986	27,595	24,668	18,551	13,941	13,613	12,401
1996	40,114	42,415	28,931	24,374	19,830	15,227	13,301	12,063
1997	37,513	32,442	30,148	25,109	21,606	18,730	14,761	12,523
1998	47,385	36,435	28,687	25,137	22,139	17,568	14,963	14,021
1999	52,436	39,579	31,524	26,668	24,843	19,827	16,482	15,045
2000	53,419	43,976	34,646	25,942	26,039	21,969	17,242	14,989
2001	53,935	40,378	30,891	28,424	25,327	24,189	17,736	16,321
2002	49,339	41,238	32,648	28,160	22,426	23,152	16,500	14,240
2003	50,000	44,974	31,687	27,210	20,079	22,420	15,574	14,240
Average	45,598	38,517	30,292	25,911	22,077	19,261	15,482	13,783

Source: Dept. of Census and Statistics

Table 2. Annual Production of Low Country Vegetables (Mt)

Year	Ash Plantain	Brinjal	Pumpkin	Ladies Fingers	Bitter Gourd	Cucumber	Snake Gourd	Capsicum	Ash Pumpkin
1994	39,982	62,601	58,247	37,653	20,683	17,838	20,828	10,713	7,826
1995	75,224	65,158	64,443	38,716	22,093	18,955	20,836	10,350	7,875
1996	75,478	67,653	60,964	37,020	20,310	18,002	19,293	10,381	6,437
1997	72,504	66,795	60,487	36,735	19,583	18,247	19,017	11,208	6,511
1998	78,985	68,853	54,301	38,480	20,556	19,081	18,197	11,531	7,104
1999	79,067	74,443	56,296	39,727	20,547	19,415	18,197	12,072	6,111
2000	84,221	76,522	62,309	40,723	20,796	20,127	18,100	12,245	5,789
2001	71,434	67,409	58,529	35,905	18,322	18,451	19,121	11,429	5,633
2002	68,317	70,634	59,578	37,665	20,878	20,994	17,376	11,139	6,362
2003	72,937	74,469	63,830	36,786	20,119	23,389	19,388	12,499	7,320
Average	71,815	69,454	59,898	37,941	20,389	19,450	19,034	6,697	6,697

Source: Census and Statistic Department

Fruit Production

Table 3 shows the annual production of major fruit crops cultivated in Sri Lanka. Currently, approximately 70,000 ha are under fruit production, of which 50% is under banana cultivation. Annual production is about 600,000 T of which approximately 50% is locally consumed, 30–40% is wasted and about 10% is exported. Fruit production in 2004 increased with higher output from banana (22%), passion fruit (18%), pineapple (4%) and papaya (27%).

Per capita availability of fruits is estimated to range between 3.39 kg and 26 kg/person/year according to different sources. The corresponding figure for vegetables is about 33.76 kg/person/year. Per capita requirements of fruits and vegetables based on nutritional needs are 40 kg/person/year and 75 kg/person/year respectively.

Table 3. Annual Production of Major Fruits Crops (Mt)

Year	Mango	Pineapple	Papaw (000 nos.)	Orange	Passion Fruit	Banana (000 bunches)
1994	540,119	33,274	37,443	27,529	13,769	42,453
1995	540,478	40,656	36,233	27,443	14,090	38,636
1996	489,683	41,063	33,120	27,147	9,018	34,397
1997	427,946	39,578	31,517	24,293	7,534	33,735
1998	472,683	36,825	27,367	25,095	5,771	32,072
1999	431,214	32,626	26,874	23,998	6,202	33,106
2000	431,047	34,603	24,317	26,620	10,260	33,617
2001	458,987	42,594	22,632	26,644	7,072	30,575
2002	487,228	42,432	26,310	28,083	13,400	31,719
2003	500,577	40,712	29,641	25,274	5,332	32,997
Average	477,996	38,437	29,545	26,213	9,245	34,331

Source: Census and Statistic Department

MARKETING CHAIN FOR FRUITS AND VEGETABLES IN SRI LANKA

Agricultural marketing is a complex process which incorporates a series of services and functions for moving a product or commodity from the site of its production to its point of consumption. The recent establishment of regional wholesale markets known as Dedicated Economic Centers has modified the marketing of fruits and vegetables. Currently, considerable volumes of fruits and vegetables are brought to regional wholesale markets which directly supply commodities to consuming areas.

Figure 1 shows the different types of marketing channels used to move fruits and vegetables from the producer to the consumer. These marketing channels differ, and not all marketing channels are available or accessible to all farmers. Very recently, several efficient marketing channels which by-pass the collector and the wholesaler, were established directly between farmers/producers and supermarket networks. Furthermore, some supermarket networks have established their own collecting centers in major vegetable producing areas, with improved handling, packaging and cold storage facilities.

As in the case of many other developing countries, a majority of fruits and vegetables are produced on small holdings, and in home gardens and are usually intended for local domestic markets. As such, theses commodities pass through long and complex marketing chains prior to reaching the consumer. Currently, different categories of people are involved in the fruit and vegetable marketing chain by performing various activities such as harvesting, sorting and grading, collection, transportation and sale. These include:

- Producers of fruits and vegetables
- Collectors

- Transporters
- Wholesale and retail traders
- Exporters
- Consumers

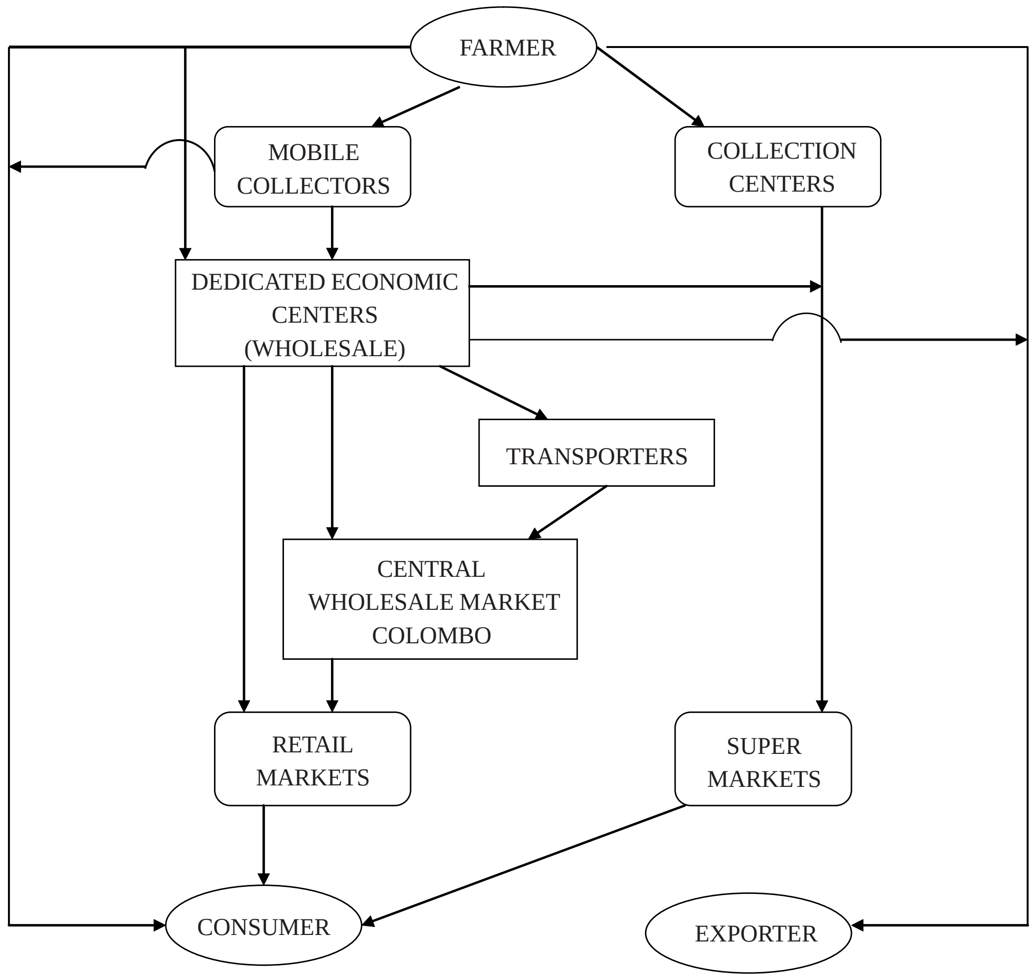

Figure 1. Fruit and Vegetable Marketing Channels in Sri Lanka

POSTHARVEST MANAGEMENT OF FRUITS AND VEGETABLES

Postharvest Losses in Fruits and Vegetables

Serious quantitative and qualitative losses occur in fresh produce, during all stages of the complex marketing chain. Results of a survey conducted by the Institute of Post Harvest Technology and Industrial Technology Institute revealed that the postharvest losses in vegetables vary between 16% and 40%, while in fruits they vary between 30% and 40%. An estimated 270,000 MT of fruits and vegetables, valued at USD90,000 are lost during postharvest operations on an annual basis. Improper postharvest management practices such as harvesting at incorrect stages of maturity, improper handling, improper packaging and transportation and inadequate storage facilities are some of the major reasons for such high postharvest losses. This leads to contamination with dusts, polluted water containing bacteria and effluents, resulting in the sale of unhygienic and unsafe horticultural produce.

Postharvest Practices

Harvesting

Fruits and vegetables are often harvested either at an immature, or at an advanced stage of maturity. Immature fruits do not ripen naturally and in cases where they do, their quality characteristics are extremely poor. When fruits are harvested too late for example, inherent physiological developments render them more susceptible to injury as when subjected to rough handling at the time of harvest and subsequently during sorting, grading and transportation. It is a common practice for the majority of vegetables to be harvested at an over mature stage. Postharvest losses in okra, beans, long beans and bitter gourd are extremely high due to toughening of texture.

Sorting and Grading

Farmers in Sri Lanka generally market their produce without either sorting or grading. Sorting and grading are currently carried out manually to some extent by wholesale and retail traders especially for sale to supermarkets. No mechanical grading and sorting facilities are available.

Vegetables such as leeks, carrots, radishes and beetroot are generally washed after harvesting to remove sand and stones, soil clods and plant debris. A majority of farmers in the up-country area use polluted water available in streams and rivers for this purpose, which may results in contamination of the vegetables with bacteria and pesticide residues.

Pretreatment and Prevention of Postharvest Diseases

Latex secretion is a major cause of quality loss in the fruit industry in Sri Lanka. Pretreatments and washing for latex removal after harvesting is rarely practiced. The Institute of Post Harvest Technology has developed pretreatment methods designed to minimize stem end rot, a major problem in the marketing of fresh mangoes.

Handling and Transportation

Losses occur primarily during transportation from the farm gate to collection centers, village fairs, wholesale markets and retail outlets. Rough handling causes mechanical damage and poor packaging and distribution aggravate the problem. Vegetables are often packed tightly by forcing into polypropylene sacks. These sacks do not provide sufficient ventilation, leading to a temperature build up which accelerates both toughening and senescence. Fruits and vegetables packed in poly-sacks are generally kept near roadsides until picked up by collectors. This allows exposure of the fresh produce to sun or rain. Rough handling takes place during transportation and loading. Because of the high transportation cost, the maximum amounts possible are transported by the collector or wholesaler. During transportation, sitting and sleeping on the poly-sacks in which fruits and vegetables are tightly packed is a common practice. Packaging used by traders, does not accommodate or compensate for bad road surfaces and high temperature and humidity conditions that prevail during extended periods of transportation, resulting in a rapid deterioration of quality. Thus produce is often bruised, infested by postharvest pathogens and is not of optimum quality on reaching distribution points.

Marketing

The infrastructural facilities of existing wholesale and retail markets are inadequate for improving the marketing and safety of fruits and vegetables. Heaps of wasted fruits and vegetables can be found near these markets. Highest losses occur at the retailer point, since damage is cumulative. With the exception of a few supermarkets and organized vegetable outlets, fruits and vegetables are exposed to sunlight and polluted environments when displayed for sale.

Fruit Ripening

Chemicals are commonly used for the artificial ripening of fruit in Sri Lanka. Although Section 26 of the food (labeling and miscellaneous) regulation of 1993 explicitly prohibits the use of calcium carbide, this chemical is commonly used by collectors and traders for the production of acetylene to induce fruit ripening. Calcium carbide is widely used for the ripening of mangoes, papayas, durians, and bananas in Sri Lanka. Acetylene is not harmful if properly used. The dosage used by traders normally exceeds the level of 1g/kg of fruit, which is recommended by the Department of Agriculture. The method used in the application of carbide is also hazardous to health, in that carbide pieces can find themselves among the heaps of fruit. Excessive use of commercial grade calcium carbide results in direct contact with the fruit causing contamination with carcinogenic compounds such as arsenic and phosphorus hydrides.

'Ethrel' is a harmless ripening-induced chemical, which releases ethylene. This compound which is recommended by the Department of Agriculture in Sri Lanka is slowly gaining popularity among fruit collectors and traders for ripening bananas, mangoes and avocados.

ISSUES AND IMPEDIMENTS TO IMPROVING MARKETING AND SAFETY

Issues and impediments associated with the improvement of marketing and safety of fruits and vegetables are socio-economic and technical in nature.

Preharvest Practices

Farmers often practice improper preharvest practices such as the use of poor quality planting material, the application of excessive quantities of pesticides, use of pesticides not recommended by authorized institutions and which do not adhere to the preharvest interval requirement prescribed by the Department of Agriculture. These factors adversely affect the quality and safety of fruits and vegetables.

Varieties and Cultivars

Lack of suitable varieties which allow the locally produced fruits and vegetables to compete in international markets and for the manufacture of value added products are another constraint to improving the marketing of fruits and vegetables. Tomato varieties grown in Sri Lanka are not suitable for manufacturing value added products such as tomato sauces. Leading manufacturers in Sri Lanka therefore import considerable quantities of tomatoes on an annual basis for the production of tomato-based products for the local market.

Seasonality of Crops

Most fruits and vegetables are seasonally produced. Excessive production during the peak harvesting season, results in a slump in prices to unprecedented levels, owing to market gluts. On the other hand during the off-season, when production is low, prices automatically increase. This situation drastically affects the efficiency of the marketing system especially in the export market due to price fluctuation and non-uniformity of supply of fruits and vegetables throughout the year.

Availability of Capital

Poverty within the farming community and the lack of capital for the acquisition of improved technologies by producers, collectors, wholesale and retail traders is apparently the major constraint to improving the marketing and safety of fruits and vegetables. Fresh fruits and vegetables are packed primarily in poly-sacks for transportation and this practice leads to serious quantitative and qualitative losses. Of the total postharvest loss in fresh produce, losses during handling and transportation alone amounts to approximately 20%. Results of a study conducted by the Institute of Post Harvest Technology revealed that the use of plastic crates for handling and transportation of fruits and vegetables reduces losses in the marketing chain from 30% to 5% and the quality and safety of fruits and vegetables reaching the consumer is appreciably improved. However, the adoption rate of plastic crates for fruits and vegetables has been very low owing to their high prices.

Marketing Channels

Lack of marketing channels that link fruit and vegetable producers and major growing areas, with urban supermarket networks and exporters, who demand quality, is yet another issue relating to the need for improved marketing.

Infrastructure

The Government has established several wholesale marketing centers, also known as Dedicated Economic Centers in various parts of the country. These buildings and their surroundings are not, however, adequately designed for proper fruit and vegetable handling. The centers lack parking facilities for loaded trucks and lorries. Space provided for wholesale traders is inadequate for the stacking of plastic crates, which are recommended for packing fruits and vegetables in order to minimize losses.

Incentives to Improve Quality

Farmers are reluctant to offer high quality produce to the common market since there in no price reward for high quality. High quality fruits and vegetables are, however, produced for supermarkets and for export. The volume of produce sold to supermarkets is of little significance when compared to the volume sold to the ordinary market.

Trained Capacity

Inadequacy of trained manpower in postharvest handling and deficiencies in agricultural extension services has adversely affected improvement in the marketing and safety aspects of fruits and vegetables. Given the large number of farmers, collectors, wholesale and retail traders in the post-production sector, there is an urgent need to strengthen the extension systems of existing public and private institutions by making use of modern communication technologies so that data and information pertaining to appropriate technologies and required standards such as HACCP, GAP etc., reach the large number of personnel involved in the existing marketing chains in a effective manner.

Market Intelligence and Information Systems

Farmers are not in close proximity of their markets and, therefore, have limited information on market requirements. Market information systems are lacking. Farmers are totally dependent on price information provided by traders or collectors. Wholesale traders and collectors in growing areas are similarly dependent on information provided by traders who operate in Colombo or in other cities.

Testing and Certification Facilities

Safety and quality standards for imported foods are enforced by many importing countries. Local exporters must, therefore, conduct inspection, testing and certification of their export commodities. Many of these services are not available in Sri Lanka. Exporters are therefore dependent on costly foreign sources for these services. Existing laboratories and testing facilities are inadequate to maintain a high export and domestic standard. The cost of analysis for pesticides residues is prohibitive, and unaffordable to the common trader or even the exporter. Currently, the analysis of a single sample would cost as much as LKR10,000.00 (USD100).

SUCCESS STORIES IN POSTHARVEST MANAGEMENT

A pilot project designed to introduce plastic crates and other improved packing materials for the handling and transportation of fruits and vegetables was carried out in two major up-country fruit and vegetable producing areas, namely: Polgahamula, Peardeniya in Kandy district and Keppetipola in Badulla district in Sri Lanka. The objective of this project was to minimize quantitative losses at different stages of the postharvest chain and to ensure that fruits and vegetables are kept fresh and safe from the time of harvest until they reach the consumer, through the adoption of correct postharvest techniques by linking personnel involved in the marketing chain.

Under this program, personnel involved in the entire marketing chain, namely, farmers, collectors, traders, consumers and also public and private organizations engaged in postharvest activities, as well as banks were sensitized to the magnitude of postharvest losses and deterioration of quality and safety in fruits and vegetables during marketing. These stakeholders were also advised on measures to eliminate waste, minimize losses and improve marketing and safety, which would benefit all stakeholders in the marketing chain, from farmers to retailers and the consumers. The target groups were informed and sensitized through discussions, the conduct of training, workshops and demonstrations as well as through the distribution of informative materials.

Plastic crates were introduced either through the provision of a subsidy to collectors and traders, or through the provision of concessionary credit facilities through development banks for the acquisition of plastic crates and other improved forms of packaging.

Introduction of Plastic Crates at Subsidized Rates to Collectors and Traders of the Marketing Chain

Two marketing chains were established in order to link farmers of the up country vegetable growing area, namely Keppetipola, to the Maning market, which is the central distribution center in the capital of Sri Lanka, that supplies quality up-country vegetables to urban consumers through collectors/whole sale traders in the collecting center (Dedicated Economic Center) in Keppetipola. Under this program farmers involved in this chain were trained in proper harvesting practices such as correct time of harvest, maturity indices for selected vegetables, sorting and grading, correct handling and transportation and also preharvest practices such as the proper use of pesticides on vegetables. The collectors and wholesale traders were trained in sorting and grading methods and in correct methods of handling and transportation.

During this exercise collectors and wholesale traders were encouraged to acquire plastic crates through the provision of direct subsidies. For each plastic crate purchased, one crate was given free of charge by the Institute of Post Harvest Technology. The collectors and traders met farmer requirements for packaging. Grading, sorting and packing of vegetables were performed by farmers who were given price incentives for quality produce.

The outcome of this exercise revealed that the use of plastic crates for handling and transportation of vegetables reduced losses occurring in the marketing chain from 30% to 5% and the quality and safety of vegetables reaching the consumer were appreciably improved. The cost benefit analysis of using plastic crates against the poly-sacks for transportation of vegetables from the collection center (Dedicated Economic Center, Keppetipola) to the central (Manning) market, Colombo is given in Table 4.

Table 4. Cost Benefit Analysis of Using Poly-sacks and Plastic Crates for Transporting Vegetables from the Collecting Center, Keppetipola to the Central (Manning) Market in Colombo

	Use of poly sacks	Use of plastic crates
1) Capacity per truck load		
- Number of units transported	80 bags	125 crates
- Average weight of vegetables per unit	50 kg	20 kg
- Total capacity	4,000 kg	2,500 kg
2) Unit price of a package LKR	30.00 per bag	527.00 per crate
3) Lifespan of package	2 journeys	240 journeys
4) Farm-gate purchasing price of vegetables LKR	25.00 per kg	27.00 per kg
5) Transport cost LKR		
- Keppettipola to central market	2,500.00	2,500.00
- Return journey	-	625.00*
6) Handling charges LKR	6.00	6.00
7) Selling price of vegetables LKR	30.00	37.00
Capital cost		
1) Total cost of packages LKR	2,400.00	65,876.00
Fixed cost		
1) Depreciation of packages LKR	1,200.00	274.00
Variable		
1) Total transport cost	2,500.00	3,125.00
2) Loading and unloading cost	960.00	1,500.00
3) Cost of vegetables	100,000.00	67,500.00
Total cost	104,660.00	72,399.00
Total revenue	120,000.00	92,500.00
Net profit	15,340.00	20,100.00

* Empty crates occupy 1/4 of the total truck capacity 1USD= 100LKR

Introduction of Plastic Crates by Providing Concessionary Credit to Members of the Fruit Collectors Association, Polgahamula in Kandy District

Members of the Fruit Collectors Association, who are collectors and traders, collect fruits such as mangoes and avocados from farmers island wide and supply common markets in urban areas. Collectors themselves are responsible for the harvesting of fruits. Prior to introducing the plastic crates, poly-sacks, used cardboard boxes and tea chests were used as packaging materials. Fruits are sometimes heaped in trucks without any packaging. In the past, fruit ripening was carried out in an ad hoc manner, with the use of excessive quantities of calcium carbide.

Under this project, plastic crates were acquired by members of the fruit collectors association through concessionary credits provided by Development Banks. This arrangement was very successful and within six months of initiating the program more than 50% of the membership acquired approximately 4,000 plastic crates at their cost to transport mangoes and avocados to the common market. Collectors and traders were trained, participated in demonstrations and in individual discussions on best postharvest practices including proper harvesting of mangoes and avocados. These training and demonstration exercises resulted in only mature mangoes and avocados being harvested, with the use of improved tools. In addition, ethrel, a chemical use for inducing fruit ripening, recommended by the Department of Agriculture grew in popularity among members for use in the ripening of mangoes and avocadoes.

The use of plastic crates for the packing and transportation of mangoes and avocados reduced losses from 30% to 6%.

Introduction of Low Cost Evaporative Cooler to Vegetable Retail Outlets to Minimize Postharvest Losses and Improve the Quality and Safety of Fruits and Vegetables

Large quantities of fruits and vegetables are wasted at retail outlets on a daily basis, owing to the lack of proper storage facilities. Retail traders in Sri Lanka cannot afford to acquire cold storage facilities owing to high initial cost and high operating cost of these facilities. In order to minimize waste and to maintain the quality of fruits and vegetables for sale at retail outlets, a low cost 'Evaporative Cooler' jointly developed and modified by the Institute of Post Harvest Technology and the University of Peradeniya, Sri Lanka was introduced to three retail traders in Anuradhapura district which is one of the major low country vegetable producing districts in Sri Lanka. This cooler can be constructed from materials which are readily available at the rural level. It has a capacity of 100 kg of vegetables. Temperatures within the cooler are 5 to 7°C lower than ambient temperature and the relative humidity is 90–95%. (Figure 2).

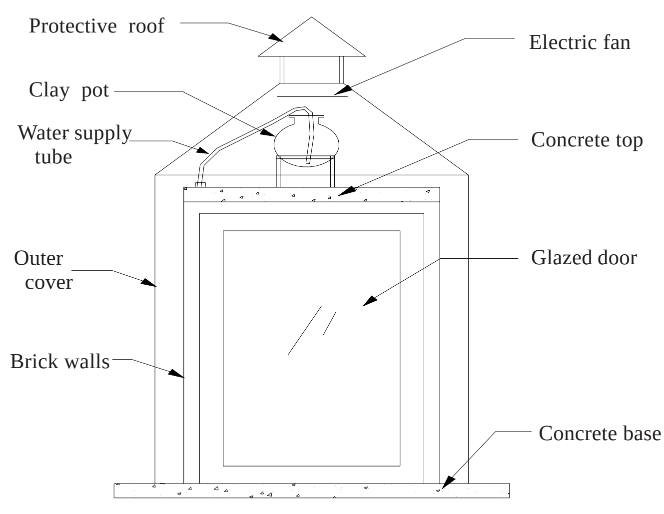

Figure 2. Evaporative Cooler

This evaporative cooler can be used for the temporary storage of unsold vegetables and reduce losses which occur at the retail point of the marketing chain from 20% to 5%, while improving the quality and safety of vegetables.

RECOMMENDATIONS

a) Adoption of proper preharvest practices is an important factor to be considered for improving the marketing and safety of fruits and vegetables in Sri Lanka. This includes the introduction of good quality plant material that will not only produce high yields, quality produce and resist pest and pathogen infestation, but will also be acceptable to the market for which it is intended. It is also important to introduce new hybrid varieties to obtain higher yields and better quality produce.

b) Under the Pesticides Act presently enforced in the country, field officers of relevant institutions should be authorized to detect and prosecute the violators of provisions of the Act namely, the sale of unregistered pesticides for use on fruits and vegetables and the application of pesticides to fruits and vegetables which do not adhere to the preharvest interval requirement which is 14 days prior to harvesting, prescribed by the Department of Agriculture.

c) The preharvest application of botanical pesticides to vegetables is one solution for improving the safety of fruits and vegetables. The Department of Agriculture recently recommended the use of Neem (*Azardiracta indicahas)* for the control of cabbage caterpillars. Commercial neem preparations are currently available in local markets. Farmers are also encouraged to produce organic fruits and vegetables in order to reduce the use of pesticides.

d) Although codes of practice have been developed by the Sri Lanka Standards Institution in order to improve the marketing and safety of fruits and vegetables such as pineapples, rambutans and bananas, there is an urgent need to develop Good Agricultural Practices (GAP) and Good Manufacturing Practices (GMP) for all economically important fruits and vegetables. The use of GAP during growing, harvesting, sorting, packing and storage operations for fresh produce is key to preventing pathogen contamination. GAP involves the application of available knowledge to the sustainable use of the natural resource base for the production of safe and healthy fruits and vegetables in a humane manner, while achieving economic viability and social stability. GMP also reduces the risk of contamination of fruits and vegetables during harvesting, handling, packing, storage and transportation.

   Development of HACCP systems for the handling of individual horticultural produce items will pave the way to improving the marketing and especially the quality, hygienic conditions and safety of fruits and vegetables.

e) Establishment of pack house facilities having basic requirements such as washing tanks, sorting and grading devices and cold storage facilities at the premises of the Dedicated Economic Centers (collecting centers) in major fruit and vegetable producing areas in the country, will overcome the problems of quality deterioration, contamination of fresh produce with harmful bacteria and other extraneous matter and will improve the safety of produce to a great extent.

f) Availability of concessionary credit facilities and subsidies to farmers, collectors and traders so as to allow them to acquire improved postharvest techniques and equipment such as plastic crates, packaging, pack houses and cold storage facilities that will overcome the drawbacks of improving the marketing and safety of fruits and vegetables.

g) Inadequate and poor conditions of transport cause considerable damage to horticultural produce. The Government should, therefore, consider allowing the tax free importation of trucks specially designed for the transportation of fruits and vegetables, and other sorting/grading equipment and packaging materials for the fruit and vegetable sector.

h) Creation of efficient marketing channels which link producers, urban supermarket chains and exporters thereby allowing them to sell their value added produce at attractive prices.

i) Technology transfer mechanisms at the Institute of Post Harvest Technology and other institutions should be strengthened in order to facilitate the effective transfer of improved technologies as well as information on improved marketing systems and food safety to farmers, collectors, wholesalers and retail traders. Improving the training and extension facilities of relevant institutions will ensure effective technology transfer of improved postharvest technologies for fruits and vegetables to farmers and other relevant groups.

j) Upgrading existing food laboratories to allow for the analysis of pesticide residues is also very important for improving the marketing and safety of fruits and vegetables.

h) The provision of adequate resources to facilitate national institutions in undertaking research activities on postharvest management of fruits and vegetables.

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22. THAILAND (1)

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INTRODUCTION

Thailand is famous for the production of tropical fruits and vegetables. A large proportion of these fruits and vegetables are of a high water content and have high respiration rates. Millions of bahts worth of horticultural crops are lost on an annual basis in Thailand, owing to poor postharvest treatment and handling. This problem has long been recognized and addressing it has been a high priority in making the horticultural industry competitive.

No official survey has been conducted to estimate postharvest losses in fruit, in the country. Some researchers, however, estimate that about 25% of fresh fruit production is lost after harvest, particularly during harvesting or transporting the fruits from field to market in the absence of proper packaging. Boonyakiat et al. (1987) first reported losses in vegetables produced in highland areas. The postharvest losses of vegetables shipped by truck from production sites around Chiang Mai, in northern Thailand, to packing stations were reported to be as high as 60% for cabbages and tomatoes, 50% for head lettuce and cauliflower, 30% for bell pepper and 17% for Chinese cabbage. The levels of losses show seasonal variation, but can be significantly reduced with the use of improved containers and packaging materials. Physical damage to head lettuce shipped from Chiang Mai to Bangkok was reduced from 35.8% to 12.6% when rigid plastic crates were used instead of conventional bamboo baskets.

Amuttiratana and Passornsiri (1992) reported losses in various vegetable crops between the farm and wholesale markets (Table 1) and between wholesale and retail markets (Table 2). Such losses average around 17% but could go as high as 30–35% depending on weather conditions and the distance over which the produce is transported. Unfortunately, such information is not available for fruits and local vegetable crops. Major reasons for these losses, include:

Lack of Reliable Maturity Indices for Farmers

Farmers harvest the crop either too early or too late. As the result, the quality of the produce is reduced and sometimes may not be marketable or edible, and hence is lost.

- *Harvesting Indices* Growers generally lack knowledge of standard harvesting indices. Moreover, many farmers sell their produce, particularly fruit, on a preharvest, contractual basis, to wholesalers who harvest the produce, themselves. Many either do not care or are not knowledgeable about maturity indices. In other cases, farmers harvest their produce prematurely in order to generate emergency income, or in order to obtain early season prices which are generally higher. This usually occurs in the case of durian, mangosteen, lychee, longan and sugar apple, since most consumers cannot judge whether or not the fruit is harvested at the right time by just looking at it.
- *Inappropriate packaging which does not protect the produce* Inadequate and/or inappropriate packaging is yet another major cause of postharvest losses. Many types of

produce are packed in bamboo baskets for transport. This packaging technique cannot generally tolerate or support the weight of other produce or other materials on top of the package. Often, bamboo baskets, each containing 15–40 kg of produce, are stacked up to ten high on trucks. The quality of produce in these baskets is therefore very poor on arrival at their destinations. Amuttiratana and Passornsiri (1992) demonstrated that the larger the quantity of produce per package, the higher was the level of losses incurred (Table 3).

- *Poor produce handling and lack of appropriate postharvest treatments* Information on the treatment of produce before and during handling and storage is very limited. Only those in universities or research institutes are aware and well-informed of postharvest technology.

Table 1. Losses between the Farm and the Wholesale Market in Thailand (%)

Crop	Weight loss	Defects	Crop	Weight loss	Defects
Gourd	1.33	1.48	Kale	3.41	4.83
Bitter gourd	1.59	2.19	Lettuce	2.87	2.58
Cucumber	2.55	3.77	Rape	2.87	2.35
Butter gourd	1.25	2.53	Chive	2.88	2.35
Sweet pepper	4.88	5.13	Chinese cabbage	1.57	3.32
Pepper	3.26	3.96	Parsley	8.47	7.73
Tomato	3.33	6.89	Spring onion	4.81	4.49
Cabbage	1.49	3.19			

Source: Amuttiratana and Passornsiri, 1992

Table 2. Losses between the Wholesale and Retail Market in Thailand (%)

Crop	Weight loss	Bruise	Rot	Trim	Total
Cabbage	0.64	3.26	0.18	7.01	11.09
Cauliflower	0.98	0.62	0	9.76	11.36
Chinese cabbage	1.92	2.95	0.11	4.48	9.46
Spinach	2.77	1.06	0	14.43	18.26
Leaf mustard	3.92	4.69	0.29	4.11	13.01
Rape	2.13	2.62	0	3.32	8.07
Chives	1.28	3.18	0.15	5.63	10.24
Lettuce	1.32	2.48	0	2.50	6.30
Kale	1.22	2.55	0.14	8.21	12.12
Water spinach	1.40	3.96	0.27	3.23	8.86
Parsley	1.78	3.02	0.50	2.32	7.62
Spring onion	1.45	3.11	0.43	4.33	9.32
Cucumber	2.43	4.71	0.07	0	7.21
Gourd	0.50	7.59	0	0	8.07
Chinese radish	1.91	1.38	0.22	6.44	9.95
Chili	2.56	4.56	0.20	0.14	8.46
Tomato	0.41	9.03	0.05	0	9.49
Yard long bean	1.61	2.42	0	0	4.03

Source: Amuttiratana and Passornsiri, 1992

Table 3. The Deterioration of Vegetables Packed in Different Unit Quantities in Polyethylene Bags in Thailand (%)

Quantity	Kale				Cucumber		
	Weight loss	Bruise	Trim	Total	Weight loss	Bruise	Total
15 kg	0.33	4.36	8.38	13.07	0.50	4.85	5.35
10 kg	0.12	2.27	4.51	6.91	1.01	3.95	4.96
5 kg	0.00	2.55	3.06	5.61	1.26	3.04	4.30

Source: Amuttiratana and Passornsiri, 1992

- *Poor temperature and humidity control* A majority of growers, wholesalers and retailers are small business enterprises and, therefore, cannot afford to build produce treatment plants of a commercial scale.
- *Poor transportation and road infrastructure* Poor roads in the field and field-level equipment such as field-trucks damage produce.
- *Low prices on the local market which discourage the use of expensive packaging and transport* A variety of fruits and vegetables are available on a year-round basis in Thailand. Prices for fresh produce are high at the early stages of production and decline during peak periods of production. During periods of glut production, consumers are able to select the most competitively priced produce.

Postharvest handling practices have been gradually developed for selected crops. Improvements have been made in storage and in packaging. Plastic boxes are now popularly used for the transportation of high-value crops such as litchis and longans for export to Singapore and Hong Kong. Corrugated boxes are also widely used in the packaging of fruits such as durian, rambutan, mango, mangosteen, banana, grapes, for export. The use of corrugated boxes was recommended on the basis of research conducted at the Thai Packaging Center which was established in 1982 at the Thailand Institute of Scientific and Technological Research. Fresh vegetables packed in polyethylene bags are available in supermarkets. The use of this modified atmosphere storage technique was adopted directly from foreign countries, and has been very well accepted by Thai consumers.

RECENT DEVELOPMENTS IN THE MANAGEMENT OF POSTHARVEST LOSSES IN FRUITS AND VEGETABLES

Despite the many programs to reduce postharvest losses in horticultural crops, progress in reducing these losses has been slow. This is partly due to the fact that the cooperative system has not grown as rapidly as hoped, and partly because of the strong production focus of Thai farmers.

The small size of production units also contributes to losses in produce. Produce collected and transported from small farms is often highly variable in size and quality, and thus cannot be readily standardized, graded and stored. Poor infrastructure, the lack of marketing facilities, and a cold chain system, results in considerable postharvest losses in fresh produce. The rate of decay of tropical produce is further accelerated by the warm, humid climate.

Packing house facilities and a cold chain are, however, used in preparing produce (e.g., durian, mango, baby corn, chilli pepper) for export.

Minimally processed fruits and vegetables are gaining popularity in Thailand. Minimal processing involves cleaning, peeling, cutting, slicing, packaging, or processing by any means short of denaturing the fruit or vegetable tissues. Durian, jackfruit, mangosteen, papaya, pineapple, pummelo, and young coconut are often marketed in the minimally processed form in Thailand. Major reasons for the minimal processing of these fruit include:

- *Large fruit size* Several tropical fruits are bulky. A single fruit may weigh more than 10 kg. Thus minimal processing allows the fruit to be conveniently packaged in quantities appropriate to consumer needs.
- *Risk of obtaining poor quality pulp* Pulp quality varies greatly. Thus minimal processing allows high quality pulp to be marketed.
- *Difficulty in peeling* Durian has numerous sharp spines that are dangerous to consumers, if not skilled in opening the fruit. Jackfruit contains gummy exudates that can stain clothing and adhere to the hands.

Relatively little research and development has, however, been done on the minimal processing of fruits and vegetables. Preparatory techniques require improvement to minimize injury and to avoid contamination. Packaging and storage conditions must be determined for each commodity, in order to maximize quality and shelf life. The issue of safety must be taken seriously since even a minor mistake could lead to disaster and to the demise of the minimal processing industry.

SALIENT APPROACHES AND TECHNOLOGIES APPLIED IN REDUCING POSTHARVEST LOSSES IN FRUITS AND VEGETABLES IN THAILAND

Longan and lychee are two highly perishable tropical fruits. Special attention must therefore be paid to their postharvest handling. Both fruits must be pre-cooled in order to remove field heat, reduce desiccation and prevent browning of the rind. They must also be fumigated in order to prevent fruit decay due to saprophytic surface fungi.

Tongdee (1993) reported on the application of sulphur dioxide as a fumigant to control saprophytic surface fungi and prevent the browning of fresh longan and lychee for export. In the fumigation system, SO_2 gas is added to an enclosure in order to control or eliminate undesirable microorganisms. This fumigation system also takes into consideration the scale of operations, compatibility with the existing handling, packaging, and marketing systems, and socioeconomic circumstances in Thailand. The high concentration-short duration fumigation system is best suited to longan under the present handling system in Thailand, where the transportation period to major longan importing countries is less than 2 weeks. The commercial use of this sulfur treatment was commercially implemented by Thai exporters in 1989. Its use is now widespread. In anticipation of more widespread use of this technology, a code of “Good Agricultural Practices” was drawn up by the Thailand Institute of Scientific Technological Research. The quality assurance scheme for this “GAP” covered:

- Inspection and certification of fumigation facilities;
- Fumigation process and post-fumigation operational control; and
- Residue monitoring, reporting, and labeling.

SUCCESSFUL CASES OF POSTHARVEST MANAGEMENT OF FRUITS AND VEGETABLES

Durian

Considerable attention is paid during the harvesting and postharvest handling of durian in order to assure quality of the fruit. Meticulous harvesting and sorting and care during transportation, contributes to excellent quality fruit for both domestic and foreign markets (Figure 1). This high level of postharvest handling has resulted in Thailand becoming the world's largest exporter of fresh and frozen durian fruit.

A 7-day shelf life from harvesting to market is the industry standard for durian. The journey from Thailand to Taiwan by sea freight, takes 6 to 7 days. Increasing the shelf life by an additional few days up to two weeks will therefore be of commercial significance. Taste and sensation associated with eating a durian, by all accounts, is intrinsically affected by maturity at harvest. Fruit that are harvested prior to the minimum stage of maturity are of inferior quality. The storage life of durian fruit is related to the storage temperature and to the stage of maturity at harvest. The fruit may show symptoms of chilling injury when stored at a temperature below 14°C.

Harvest

Transport to Packing House within 6 hours after harvest

Requirements:
- Avoid contact of fruit with soil
- Minimum harvest maturity
- Use clean container
- Avoid mechanical injury during transportation

↓

Packing House

Requirements:
- Grower identification
- Grower agreement statement
- Produce specifications

↓

Packing Line Operation

Packing House Operation Complete within 4 hours

Steps:
- Fruit receiving
- Fruit pre-grading for size, shape, maturity, disease, surface insects, blemish
- Labeling of individual fruit
- Fruit cleaning/washing
- Postharvest fungicidal treatment
- Fruit quality inspection for maturity and disease

Option:
- Short-term stocking for 1–2 days for additional quality check
- Check for insect infestation
- Size grading and labeling
- Packing in Cardboard boxes

↓

Palletizing

Completed pallets move to cold store or refrigerated container in 2–4 hours

↓

Container loading

Requirements:
Pulp temperature as close to container setting as possible at 15°C

Figure 1. Handling Protocol for Fresh Durian (Tongdee, 2002)

Harvesting Method

- Thai durian is generally harvested at 80–90% of its physiological maturity. The fruit ripen 5–10 days after harvest, and can thus be stored, distributed and exported. During storage and transportation the ripening process continues.

- Fruits which are harvested at the fully mature stage are generally overripe on reaching their destination. Overripe fruit are considered to be of inferior quality, and command a low price owing to rejection by the consumer.
- Harvesters normally work in pairs: one who selects and harvests the fruit on the tree, while the other serves as a catcher below the tree. Fruit are harvested by cutting with a clean knife, while leaving about 10 cm of stem attached. The fruit are subsequently dropped to the catcher and are commonly caught using a jute bag to prevent them from dropping directly to the ground. Although fruit can be harvested at a relatively rapid rate using this method, a reasonable level of skill is required in order to avoid breakage of the stems or allowing the fruit to sustain mechanical injury by dropping to the ground.
- Harvested durians are transferred to a container, e.g., a plastic or bamboo basket in order to guard against fungal infection which can cause rotting during transportation and distribution.

Sorting and Grading

Sorting and Grading for the Domestic Market After harvesting, unmarketable fruits are separated from marketable fruits by the grower and trader. Fruits which are irregular in shape, diseased, and damaged by rodents or insects are designated upgraded, and are marketed at a low price. Graded durians are of high quality and are marketed at a premium price. The price difference is dependent on the variety, size and appearance of the fruit. Factors which influence the marketing characteristics of durian include:

- Maturity Index: Fruit are harvested at 80–90% maturity (the mature green stage);
- Method of harvest: Whether the fruit was harvested from the tree (not allowed to drop);
- Variety of the fruit: Whether the fruit is of the Chanee or Monthong variety;
- Weight of the fruit: Fruit weigh between 2 and 4 kg, depending on the variety. Monthong fruit are, however, larger than Chanee fruit;
- Shape of the fruit: Fruit must be of the correct shape.

Sorting and Grading for Export In an effort to encourage quality improvement, the Thai Ministry of Agriculture and Cooperatives have prescribed standards for durian fruit destined for the export market. These standards which are voluntarily applied include the following:

- Size
  - Weight of fruit of the Chanee variety: 2.0–3.5 kg
  - Weight of fruit of the Monthong variety: 2.0–4.5 kg
  - Weight of fruit of the Kanyao variety: 3.0–4.5 kg
- Shape
  - Fruit must have at least 4 locules, with all pulp seeds in good shape in accordance with varietal characteristics.
- Pulp color
  - The color of the pulp varies in accordance with the variety of the fruit. The pulp of Monthong fruit may be pale, while that of Chanee fruit may be yellowish in color.
- Visual appearance
  - The fruit must be free from pests and diseases with minimal visual defects.
- Internal characteristics when ripe
  - Fruit should have neither a wet core, nor show any signs of browning.

Packaging

Domestic Market Durians destined for the domestic market, are generally stacked in bulk in trucks, and covered with either jute bags or canvas to protect them from direct sunlight, and from rain. Upon reaching the market, they are stacked either on jute bags, cardboard or canvas. High quality fruit may be displayed either by placing on a shelf or by hanging.

Export The packaging of durian depends on the requirements of the destination market. Durians exported to Hong Kong, Republic of China and China are securely packaged in 10–12 kg corrugated cardboard boxes. Each box contains 3 to 4 fruits. Larger boxes having a capacity of 6 to 8 fruits are also used to reduce the cost of packaging. Wooden crates are used for the export of durians to Malaysia and Singapore, owing to their low cost, as compared to paper boxes. Wooden crates of 10–30 kg capacity, and which can carry between 4 and 15 fruits each, are used.

Transportation

Transportation to Domestic Markets Unpackaged fruit are generally transported by truck over a 1 to 2-day period. During transportation, the trucks are covered with canvas in order to minimize exposure to direct sunlight.

Transportation of Fruit Destined for Export Markets The mode of transportation is dependent on the distance over which the fruit are to be shipped. Durians destined for nearby countries such as Malaysia and Singapore, are usually transported by truck, while those destined for Hong Kong, Republic of China and China, are generally transported by sea. Air transportation is the best mode of transportation for fruit destined to distant countries such as the USA and Europe.

Longan

Longan fruit have a short shelf life, owing to their high sugar content. Under ambient conditions in Thailand (25–31°C), the rind of harvested longan fruit turns brown within 3–4 days, and the aril rots within a week. The shelf life can be extended by a few days, by storage at 18°C. Hydro cooling or forced air cooling coupled with low temperature storage can, however, increase the shelf life of longan fruit.

Processing of Longan Fruit Due to the short shelf life of fresh longan fruits, they are processed into a number of value-added products. Value-added products of longan produced in Thailand, include canned longans, dried ‘longan nuts’, longan nectars and frozen longans. Large fruits such as those of the cultivars ‘Biew Khiew’ and ‘Daw’ are generally preferred for canning. Relatively little sugar is required during the canning process as the fruits are canned in their own juice which is of a high brix. Canned longans are thought to have better flavor retention characteristics than canned ‘rambutans’ and lychees.

Longan fruits are dried either intact or after removal of the pericarp. Small and medium fruits are preserved by drying. The process of drying longan fruits involves boiling the fruit for five minutes, followed by sun or oven drying at 55°C, and then at 70°C until the fruit is completely dried. The drying process lasts 19–20 hours. Dried intact fruits show better flavor and aroma retention when compared to fruits which have been dried without the pericarp. Dried longan fruits have a moisture content ranging between 18 and 19% a sugar content of 60–65 °Brix.

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23. THAILAND (2)

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INTRODUCTION

Fresh fruit and vegetable exports from Thailand have shown an increasing trend over the years. Globally, Thailand is ranked as the 14th largest exporter of agriculture and food products. Since the 1980s, Thailand's horticultural export trade has shown a consistent pattern of growth, having increased in value from USD11 billion in 1980/1982 to USD20 billion in 1990/1992, to USD44 billion 2000/2002. Fresh produce accounts for 70% of these exports, while processed products account for 30%. Growth in Thailand's fruit and vegetable sector exceeds that for other commodities by between 8 and 10%.

Postharvest management of horticultural produce is very critical to enhancing the shelf life and to reducing losses in export trade. The level of management required varies in accordance with the target market. Produce destined for international markets requires intensive handling and management while much less handling and management is required in the case of produce destined for local markets.

Consumer attitudes toward food have undergone progressive change over the past four decades. In the late 1970s, price was a major determinant for consumers, while in the early 1980s, visual quality, such as well kept and attractive packages was the prime determinant for consumers. By the late 1980s, convenience became a major issue with consumers, with growing consumption of fast food, minimally processed food, frozen goods and ready-to-eat meals. From 1990 to the present, food safety has been the main issue. Consumer concern for pesticide residues, microbiological and pest contamination, sanitation of food and processing environments, worker hygiene, plant health and animal welfare have also increased.

Farm to table quality management systems include Good Agricultural Practice (GAP), Good Manufacturing Practice (GMP), and Hazard Analysis Critical Control Point (HACCP). Government policy provides for the control of product quality at every step of the food chain. In 1999, which was designated the GAP Year, Government, through the Department of Agriculture (DOA) encouraged farmer registration in GAP projects. Similarly the year 2004 was designated a Food Safety Year, with promotion of the production and consumption of high quality produce by the Government. The government has a further national agenda to promote Thailand as 'Kitchen of the World'.

In 2004, there were 244,537 farmers or 1,364,221 rai (1 acre = 2.5 rai) registered in GAP projects, of which only 34,839 farmers or 194,360 rai, attained GAP certification. Future plans of the Government are to integrate the participation of all farmers in GAP projects. Registration in such projects would allow government officials to visit farms and to provide advice on chemical use. Between 7 and 10 days prior to harvest, the use of chemicals is prohibited. Random samples are collected from farms and analyzed for pesticide residues.

The presence of pesticide residues on produce results in the request for farmer withdrawal from the project. Harvested produce is transported to packing houses and is again randomly sampled and further analyzed for chemical residues.

GMP and HACCP projects monitor the management of fresh produce from packing house to consumer. In 2004, 200 packing houses attained GMP certification, while 16 attained HACCP certification. Both the GAP and GMP/HACCP projects, award a Q mark which denotes a high level of safety and quality to producers/exporters and freedom from chemical residues on analysis.

IMPEDIMENTS TO IMPROVING MARKETING AND SAFETY

Human Resources

Thailand's farming population is relatively poorly educated. Farmers lack knowledge on:

- Production technologies with limited chemical use;
- Windows of opportunity for the harvesting of mature fruit to secure good returns;
- Environmentally sound practices;
- Postharvest management practices which prolong the shelf life of their commodities;
- Practices which extend the production cycle for horticultural produce, e.g., the use of Pachobutrazol (Giberrelic acid inhibitor) to induce flowering in durian during the off season.

Thailand also currently faces a labor shortage and employs a large number of migrant workers in its horticultural production sector.

Facilities

Cold storage facilities and refrigerated transportation systems are limited. Produce therefore undergoes rapid deterioration.

Transportation

Air Transport

- Current air transportation facilities are inadequate during the peak season of production, which spans the period May to July.
- Government Order Rate (GOR) for fresh produce is lower than that for other goods such as garments, although the rate is still considered too high for exports. Thailand cannot compete with other exporting countries such as Central America and Africa, given the high cost of air transportation which accounts for between 25 and 76% of the price of produce in the importing countries.
- Airport storage facilities are inadequate.

Transportation by Sea

- Shipping facilities are more easily accessible in terms of space availability, than are air cargo facilities. In situations where there are fewer imports than exports, the cost of ordering a vacant container accounts for 85% of the cost of transportation. Transport costs are therefore very high.
- Lack of storage rooms and facilities

Road Transport

- Refrigerated trucks are not suited to produce requirements.

- Given the high cost and shortage of energy, campaigns have been launched by the Government in an effort to reduce the use of energy.

Packaging

Packaging is, in general, unattractive to consumers and unsuitable for the prevention of mechanical injury or other damage. Grading and packaging facilities at the farm level have not been improved and farmers continue to sell ungraded products and use traditional methods of packaging, with resultant losses during transit leading to high marketing costs and low returns.

Marketing

Markets are not consistent with the supply especially at peak season.

Plant Quarantine

Stringent rules and regulations of importing countries can hinder the progress of exporting markets.

Information Systems

Thailand still lacks information systems. A majority of farmers do not know how to use the internet.

Weak Certification Systems

MAJOR POSTHARVEST PROBLEMS IN THAILAND

Major postharvest problems in Thailand stem from:
- Inferior fruit quality due to immature fruit (as occurs in the case of durian)
- Uneven ripening
- Fruit rot: *Phytophthora*, *Lasiodiplodia*
- Fruit cracking
- Physiological disorders
- Chilling injury

Control Measures
- Proper maturity at harvest
- Artificial ripening
- Fungicide treatment
- Waxing and plant growth hormone
- Preharvest factors
- Avoidance of chilling temperature

GOOD POSTHARVEST MANAGEMENT PRACTICES

Fresh produce quality can only be maintained through the application of a holistic approach during production and postharvest handling. Quality management plans should be established by both the production and postharvest sectors. The key to assuring postharvest management is **'integration (co-operation) of all steps of the chain."**

Key Factors in GAP - Traceability
- Site history

- Risk assessment of site
- Storage of fertilizer
- Quality of irrigation water
- Crop protection
- IPM/Agrichemicals
- Agrichemical training
- Agrichemical recording
- Protective clothing
- Withholding periods
- Residue testing
- Postharvest washing
- Microbiological quality of water
- Postharvest chemicals
- Compliance with labels
- Registration in home country
- Permitted in exporting country
- Recording of postharvest chemical applications
- Hygiene of worker health

Key Factors in GMP

- General provision
- Buildings and facilities
- Equipment
- Production and process controls
- Warehousing and distribution
- Defect action levels

Logic Sequence for Application of HACCP

Assemble HACCP Team
↓
Describe Product
↓
Identify Intended Use
↓
Construct Flow Diagram
↓
On-site Confirmation of Flow Diagram
↓
List all Potential Hazards
Conduct a Hazard Analysis
Consider Control Measures
↓
Determine CCPs
↓
Establish Critical Limits for each CCP
↓
Establish a Monitoring System for each CCP
↓
Establish Corrective Actions
↓
Establish Verification Procedures
↓
Establish Documentation and Record Keeping

Figure 1. Key Elements of a HACCP System

Growing markets and reduced rejections in importing countries indicate the success of postharvest management practices developed for longan, mangosteen, baby corn, and orchids. Flow diagrams of these produce items are shown in Figures 2–5.

Harvest
Remove leaves and stalk
Sizing and grading
Pack & weigh
Distribute crates
Receive & weigh
Visual inspection
Designate grade and label
Stack crates in fumigation foom
Fumigate
Aerate
Cool
Stack in shipping container
Transport

Figure 2. Flow Diagram of SO_2 Fumigation of Fresh Longan

Sorting, sizing and grading
76–100 g / fruit
101–130 g / fruit
Cleaning – by strong blower to remove dirt
Vapor heating At 46°C for 58 minutes
Packing
Place sticker on every fruit
Bubble on the bottom
24 to 36 fruits / box
Transport by airplane at 13°C

Figure 3. Flow Diagram of Handling System for Mangosteen

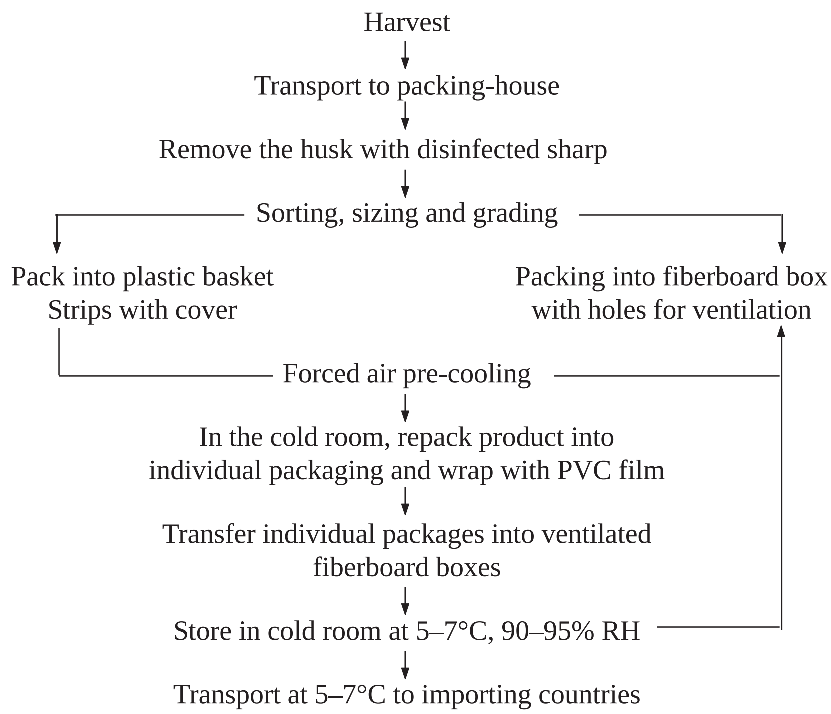

Figure 4. Flow Diagram of Handling Systems for Baby Corn Destined for the Japanese Market

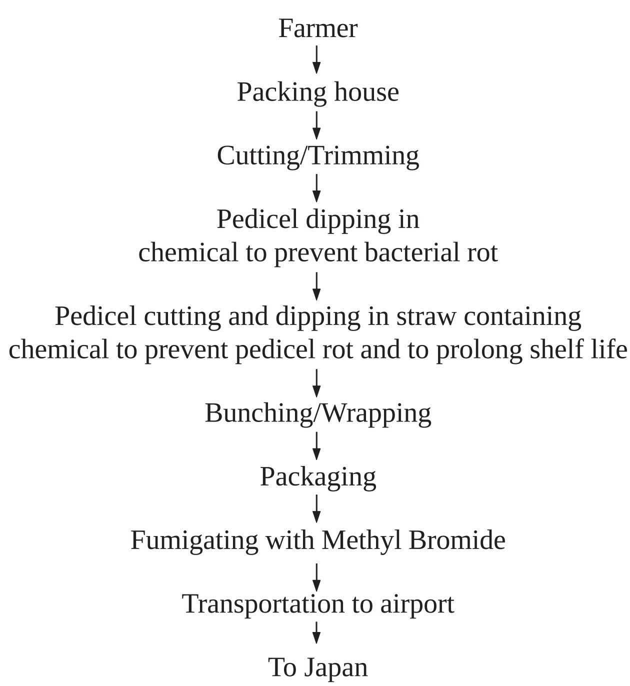

Figure 5. Flow Diagram of the Handling System for Orchid Exports to Japan

RECOMMENDATIONS FOR IMPROVING THE SAFETY AND QUALITY OF FRUITS AND VEGETABLES

Fresh produce items are highly perishable and are high value export commodities. Attention should be paid by the government to enhancing their potential for export. Quality improvement is critical to accessing export markets. Farmers should be motivated and trained to produce crops of high quality. Recommendations for improving the postharvest handling of fruits and vegetables are as follows:

Reduction of Postharvest Losses

- Initiate and coordinate awareness programs for producers, dealers and transporters on postharvest handling and on reducing losses;
- Introduce packaging techniques with modern packing materials and transport systems;
- Support training farmers in selecting the correct inputs and in postharvest handling, including cleaning, drying, sorting, and packaging at the farm gate;
- Support training in the area of food safety both for the domestic market and for international trade;
- Supporting research in the area of value addition and supply chain management.

Promotion of Production, Marketing, Packaging and Consumption as a Concept in Agriculture

- Equip wholesale markets with the capacity to accommodate the volumes of fresh produce production;
- Construct roads which link villages to nearby assembly and wholesale markets and in turn with large wholesale and terminal markets and ports;
- Create storage structures and networks of these structures from villages or rural areas to district and provincial headquarters and ultimately to terminal markets and ports;
- Encourage the establishment of cold storage facilities and refrigerated carriers to facilitate storage and transportation of perishable commodities;
- Provide adequate space for airfreight and shipment;
- Provide refrigerated vans for transportation of perishable commodities;
- Demonstrate the advantages of selling and handling graded and well-packaged products;
- Encourage technological developments in the packaging of agricultural commodities and in promoting packaging facilities appropriate to specific commodities;
- Establish primary wholesale market yards for a group of villages or in towns with all facilities including grading and quality testing laboratories, storage facilities, cold stores, processing units, packaging plants, and garbage disposal systems;
- Develop secondary wholesale market yards at district or divisional levels;
- Develop mega markets and food parks in cities or terminal markets with a higher level of all facilities;
- Amend rules and regulations that hinder greater participation of the private sector in agricultural marketing.

Development of Processing and Packaging Industries

- Promote the production of value-added products such as dehydrated fruits and vegetables through product development;
- Promote attractive presentation through appropriate packaging for specific markets such as supermarkets.

Promotion of Fruit and Vegetable Consumption

- Publicize through electronic and printed mass media;
- Organize nationwide awareness programs to educate consumers and schoolchildren on the nutritional value of fruits and vegetables;
- Collaborate with the Department of Health and Education to create this awareness.

Improvement of Information Systems

- Market information systems need to be strengthened and geared to meeting the requirements of farmers, businesses and those involved in marketing.
- Information exchange and international cooperation on Food Contamination Monitoring and Food-borne Disease Surveillance are required in order to increase consumer health protection and facilitate food safety in international food trading.

Thailand is a member of the World Health Oganization's International Programme on Chemical Safety (IPCS). This program provides information on best practices for handling produce and on problems, and risks associated with the use of chemicals, including some chemical residues in foods (e.g., pesticides). This program has proven useful for the development of a system for health protection from hazardous chemicals in the country. Thailand has participated in the Intergovernmental Forum on Chemical Safety (IFCS), which currently encourages participating countries to develop their "National Chemicals Management Profiles" and publicize these profiles through the established website of "Information Exchange Network on Capacity Building for the Sound Management of Chemical (INFOCAP)".

CONCLUSIONS

Thailand is a major producer of fruits and vegetables, and plays a key role in providing safe and nutritious foods for both domestic and international markets. Every step of the food chain should be controlled in order to assure quality and to reduce postharvest losses. Cooperation among producers, dealers, transporters, and government are the key to achieving good management.

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24. VIETNAM (1)

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INTRODUCTION

Vietnam has a total land area of about 330,000 km^2. There are two lowland deltas within the country: the Red River Delta in the North and Mekong River Delta in the South. Other areas of the country are mainly hilly and mountainous.

Vietnam's agricultural sector accounts for 21.8% of the total national GDP. With an annual population growth rate of 1.3% and a current population of more than 80 million, food security is of high priority. In 2003, Vietnam was ranked the second largest rice and coffee exporter and the fourth cashew exporter globally (CIEM, 2004). Vietnam's agricultural and food products are still poorly competitive in both domestic and world markets. A limited number of processed agricultural products are produced and agricultural products are exported primarily in the primary processed form. There is a need for the development of strong agricultural and food processing industries which integrate modern technologies.

The safety of vegetables which are a major constituent of Vietnamese diets has become a widely publicized issue in Vietnam. Fruit and vegetable consumption in Vietnam is currently estimated to be approximately about 94 kg/capita/year. Postharvest losses in agricultural produce, which generally exceed 20–30%, are of major concern. Reducing the levels of these losses necessitates postharvest management, as well as appropriate processing technologies.

Rapid growth in fruit and vegetable exports is vulnerable to restrictions in international trade. Although tariff and non-tariff barriers are being reduced by multilateral trade agreements, sanitary and phyto-sanitary (SPS) trade regulations are becoming increasingly important, particularly in the trade of fruits and vegetables. SPS import restrictions are partly a reflection of legitimate concerns of consumers in importing countries and partly a reflection of protectionist pressure from producers in those countries. Vietnam needs to develop a stronger scientific knowledge base related to SPS issues in order to address legitimate SPS concerns of importing countries, as well as to challenge protectionist use of SPS issues.

FRUIT AND VEGETABLE PRODUCTION

Vietnam's agricultural production is able to satisfy much of the country's food requirements. Rice production which amounted to 34.5 million tons in 2003 was able to satisfy the domestic demand for this staple crop and allowed 9.4% of the volume of rice produced in 2002, to be exported. Vietnam produces a diversity of fruits and vegetables, including cabbages, tomatoes, cucumbers, hot peppers, onions, mushrooms, pineapples, bananas, citrus, mangoes, litchis, longans, green dragons and rambuttan, for domestic consumption and for export. In

2003, 511,000 ha were under fruit cultivation in Vietnam, with a yield of 5.1 million tons of fruit. Fruits are generally produced in household gardens at an average scale of about 0.5–3 ha/household. Few fruit orchards exist in Vietnam.

Fruits are planted mainly in the South Me Kong River Delta. Major fruit crops under production include citrus fruits (68,600 ha orange, mandarin, and lemon), which account for 12.3% of fruit production; longan, litchi and rambutan (77,000 ha) which account for 15% of fruit production and pineapples (36,000 ha). Other fruit trees account for nearly 43% of fruit production in Vietnam. Fruit production is unstable with low yields. Orange and mandarin currently provide yields of 9 ton/ha, longan and litchi provide yields of 6 ton/ha, and mangoes yield 5 ton/ha. Approximately 638,000 ha are under vegetable production, with vegetable yields amounting to 8.3 million tons. Vietnam still has considerable potential to produce larger volumes of crops to supply food production requirements both regionally and globally.

PRESERVATION, PROCESSING AND MARKETING OF FRUITS AND VEGETABLES

Up to the year 2003, large fruit and vegetable processing plants increased processing capacity within the country to 290,000 tons of processed product/year. A number of small factories and traditional processors are also engaged in the processing of fruits and vegetables in some provinces. Currently between 5 and 7% of fruit and vegetable production is processed. Foreign investors are currently boosting investment in Vietnam's fruit and vegetable processing industry.

Domestic consumption of fruits and vegetables remains very low. Consumption of fruits and vegetables per capita are 38 kg and 56 kg, respectively, against global consumption levels of 70 kg and 85 kg. Fruits and vegetables are mainly consumed in the raw and fresh state in Vietnam.

Harvest and preservation are performed manually, using simple technologies. Relatively small quantities of the main fruits produced (litchi, longan) are processed, given the limited local technical capacity. An estimated 10% of harvested fruits are processed, while 25–30% of these fruits are lost owing to poor processing technologies and limited facilities for postharvest management and preservation.

Fruits and vegetables produced in Vietnam are sold in more than 50 countries. Exports, nevertheless, account for less than 7% of fruits and vegetables produced in 2003. Vietnam's export turnover of fruits and vegetables was valued at 153 million USD in 2003 (Table 1). Fresh fruit and vegetable exports to China, mainly by small traders, account for a substantial proportion of Vietnam's exports.

Preserving the shelf life and quality of fresh fruits and vegetables, necessitates reducing respiration rates and protecting these fresh produce items from postharvest infection by moulds and microorganisms. This can be accomplished in most cases through storage at reduced temperatures and through modified atmosphere storage.

Litchi – This is the major processed fruit produced in Vietnam. Dried litchi produced using simple technologies, accounts for 30–40% of litchi production. Much of this fruit is exported to China. Canned litchi juice is also produced. Litchi is exported primarily to China, Hong Kong and to other Asian countries.

Longan – This fruit is mainly dried and exported to China by small traders. The market for this fruit is unstable.

Orange and Mandarin – These are mainly consumed in the domestic market, in the fresh form.

Table 1. Export Turnover of Fruits and Vegetables Produced in Vietnam (1000USD)

	1997	1998	1999	2000	2001	2002	2003
Export turnover of vegetable and fruit	71,232	53,392	104,922	213,100	329,972	201,156	152,470
China	24,493	10,454	35,686	120,351	142,801	121,529	67,068
Taiwan	12,295	6,055	11,895	20,841	23,319	20,897	21,584
Japan	8,676	6,570	9,365	11,729	14,527	14,527	16,710
Korea	2,599	4,088	10,074	13,691	20,194	7,783	9,660
Russian	3,633	1,248	995	4,654	5,030	8,506	8,293
American	3,196	2,559	3,209	2,178	1,971	5,318	8,073
Netherlands	880	1,260	1,589	2,160	2,381	3,870	5,899
Cambodia		235	2,792	798	2,276	4,411	4,651
Singapore	2,442	2,322	2,073	1,226	13	3,401	4,454
Lao PDR	255	4,456	9,234	2,086	1,626	4,405	4,300
Hong Kong	3,122	5,094	3,222	3,316	4,334	4,581	3,699

Source: Trading Information Center

Vietnam faces many challenges in the area of agricultural marketing and lacks experience and capacity in conducting market research. Despite the export of fruits and vegetables to 50 counties, Vietnam's marketing structure has not changed and China is still the main importing country, accounting for 44.3% of export turnover.

Horticultural produce exports are constrained by tariff and non-tariff barriers (NTBs). It is generally agreed that the fruit sector must be prepared to confront a more liberalized trade environment. The restrictive effect of NTBs on horticultural imports is considerably greater than that of tariffs. NTBs include marketing orders such as product specifications, quotas and voluntary export constraints, import licensing, variable levies, minimum price systems, countervail taxes and duties and technical specifications (especially health restrictions, and strict labeling and packaging specifications).

FOOD SAFETY ISSUES

The traditional approach to food safety was that people at each stage of the food supply chain were responsible for the handling of food and, hence, for food assuring food safety. Many safety factors/variables must be considered in harmonizing national standards with guidelines through international consensus. Mutual recognition and agreement on food safety issues is expected to take time. Another important consideration is the need for dialogue between policy makers and producers/operators. The challenge is to provide for better communication and to put in place food safety systems that are viable and effective both in terms of cost and efficiency.

In response to public concern for vegetable safety, the Vietnamese Ministry of Agriculture launched a "safe vegetable" program in 1995. This program includes technical support to eight cooperatives for dissemination of information on the production of "safe vegetables" with regulations pertinent to the use of water and inputs, the distribution of vegetables through specific “safe vegetables shops”, and controls on pesticide residues. In 2000, there were 30 “safe vegetable” shops in Hanoi. These were linked by annual contracts to cooperatives for vegetable supply and the Service of Science, Technology and Environment for quality control. The total supply of safe vegetables was approximately 2,000 tons, which corresponded to approximately 1.5% of the total Hanoi vegetable market. In addition to obtaining supplies from “safe production” areas, efforts are made by the shops to ensure postharvest quality; sorting, cleaning of the produce, packaging under plastic, airing and sometimes cooling, and regular cleaning.

Implications of this work in terms of risk management in local vegetable supply chains include the need for:

- Development of a policy on “safe vegetable” production and distribution, in order to meet consumer demand;
- A price strategy based on: careful recording of price data in a sample of points of sale and analysis of the sources of variation;
- Improved consumer information on safe vegetable production and marketing procedures, vegetable control procedures, location of safe vegetable shops. Some of this information could be included in the packaging and labeling of produce.

Improving food quality in line with international standards and enhancing competitiveness within the food industry are critical issues. Application and implementation of effective management are necessary approaches to assuring process and product quality. On the other hand, advanced food processing technologies, applied microbiology for food production, efficient monitoring techniques for controlling food safety and quality, technologies for the production of functional and healthy foods from local materials, need to be investigated and developed.

Quality control systems are currently viewed in Vietnam as the key to competing in domestic and global markets. Total Quality Management (TQM) and established quality management systems such as quality management systems in accordance with ISO (International Standard Organization) 9000, Good Manufacturing Practices (GMP), Hazard Analysis and Critical Control Point (HACCP) have been established in Vietnam. HACCP in particular is still very new to Vietnamese enterprises. The importance of HACCP systems has, however, been recognized in Vietnam.

Vietnam lacks sophisticated laboratory equipment and trained personnel, with only few trained personnel people to follow a large and complex area. There is a general lack of cooperation between consumers and processors.

The following measures may be adopted to resolve this problem:

- Promotion and training of farmers on harvesting, postharvest methods, pre-cooling facilities and packaging;
- Application of advanced production technologies to improve output and reduce the price of fresh produce;
- Promotion efforts to enhance the export of products to the USA, Japan and China;
- Improvement of the marketing and exchange of goods between various locations within the county;
- Reinforcement of food legislation and food inspection mechanisms;
- Encouragement of processors to apply new methods of quality management;
- Improvement of relationships between consumers and processors;
- Increasing consumer awareness about food safety;

- Strengthening food legislation for the sanitation of processed food;
- Providing financial support to food testing laboratories.

FUTURE TRENDS IN FRUIT AND VEGETABLE MARKETING

Vietnam's fruit and vegetable exports now average at a value of approximately 200 million USD on an annual basis. A considerable level of investment is currently being made to expand material supply areas and for the development of postharvest technology, within the vegetable sub-sector. This sector also targets increasing the export of processed products, such as mushrooms, canned vegetables, and fruit concentrates as well as fresh produce items such as cabbages, onions, beans, pineapples, and bananas. Fruit and vegetable exports are likely to increase to 1 billion USD by 2010. According to the Ministry of Agriculture and Rural Development, vegetables will account for two-thirds of these earnings. The Ministry estimates an annual output volume of 20 million tons within a ten-year time frame, with an accompanying reduction in postharvest losses from the current level of 25% to 15%.

Projections are that processing enterprises will switch their export focus from Russia in the coming years. This will be especially so after the Vietnam-U.S. trade pact comes into effect, since transportation costs will be reduced and American import duties lowered. Measures to realize the target for 2010 include the rezoning of arable land and the promotion of research into plant varieties, as well as the application of the most recent technological developments in this area. Processing facilities will be upgraded or built alongside material zones, and quality testing centers will be established. Currently, the industry's main export items include canned pineapples, dried longans, litchis, dragon fruit and mangoes.

25. VIETNAM (2)

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INTRODUCTION

The Mekong Delta includes 12 provinces from Long An to Ca Mau. Within that region, approximately 2,800,000 tons of fruits and vegetables are produced on 234,000 ha of land on an annual basis. Tropical fruits produced in that region include citrus, longans, mangoes, durians, rambutans, mangosteens, star-apples and bananas, while vegetables produced include watercress, cabbages, onions, tomatoes, red peppers, soya-bean, pea, watermelons, cucumber and yam.

Although living standards of farmers have improved over the years, farmers lack knowledge on postharvest technologies. Postharvest losses are very high and average about 20–25% for fruits and more than 30% for vegetables.

CAUSES OF POSTHARVEST LOSSES

Losses occur due to:

1. Lack of reliable maturity indices;
2. Poor handling of fresh produce;
3. Poor transportation and/or lack of packaging during transportation;
4. Inappropriate/inadequate packaging;
5. Poor temperature and humidity control around the produce;
6. Inappropriate postharvest treatment;
7. Unsuitable use of pesticides;
8. Low market prices on the local market which discourage the use of expensive packaging and transport systems for fresh produce.

FACTORS WHICH INFLUENCE FRESH PRODUCE QUALITY

Fresh produce quality is influenced by a number of factors:

Temperatures Conditions

Plants require precise temperature conditions in order to flourish. In order for fruits (oranges, grapefruits, longans) of the Mekong Delta to achieve the maximum Brix levels, temperatures during the day should vary between 23 and 30^{o}C. However, when conditions are too warm, the fruits lack the characteristic aroma and flavor desired by consumers.

Metabolic Stress or Natural Senescence

Metabolic stress is brought about exposing fruits and vegetables to high or low temperatures. Metabolic stress has a negative impact on quality, and often renders fruits and vegetables unsaleable. Tropical fruits such as rambutans, mangoes, citrus and most vegetables are damaged if stored below 8^{o}C, due to chilling injury. Natural senescence also causes loss in quality. Age after harvest will reduce the attractiveness of color, and leads to softening and rotting.

Transpiration and Water Loss

Water loss reduces the freshness of produce. Produce displayed in supermarkets often decline in quality, owing to prolonged exposure to dry air.

Mechanical Injury

Mechanical injury leads to bruising in fresh produce, and can occur during harvest, transportation or display at the supermarket.

Microbial Infection

Microorganisms and fungi are the cause of fruit rots and thus render fruits and vegetables unsaleable.

Cardboard Packaging

Cardboard packaging can cause quality loss in fresh produce, owing to the development of musty flavor.

EFFORTS TO MINIMIZE POSTHARVEST LOSSES

Fruit and vegetable varieties, cultural practices, insect infestation and postharvest diseases were investigated in Vinh Long Province, over an eight-year period from August 1996 to August 2004. This study noted the specific requirements of individual varieties.

As a result of these studies, growers and packers have been able to improve the appearance of their fresh produce, and increase their sales. Some examples of methods that have been used to improve quality include:

- Treatment of citrus with ethylene (ethrel) to remove the green color (de-greening)
- Packing oranges and grapefruits in orange mesh bags to reinforce the color of the fruit
- Minimizing water loss. Water loss can be minimized in citrus fruit by packaging, waxing or low temperature storage. Rapid pre-cooling of fruit such as longan and rambutan also reduces water loss. Minimizing physical damage to fresh produce can also reduce water loss.
- Determination of commercial maturity. Some criteria that can be used to judge maturity include:
  (a) Time from flowering – measure the number of days from full bloom (longan, mango, rambutan)
  (b) Size and shape, this can be done using fruits sizing circles (longan)
  (c) Skin or flesh color (rambutan, clump)
  (d) Time to ripen (orange, grapefruit)
- Minimize the period over which the fruits and vegetables are marketed
- Low temperature storage (8–12^{o}C) depending on the type of fruit or vegetable

CONCLUSIONS

Reducing postharvest losses will be of economic and environmental benefit to Vietnam. Actions to be taken in this regard will include:

- Reducing current levels of postharvest losses to a minimum (<10%);

- Adoption of international standards in order to increase the value of fruits and vegetables;
- Train postharvest personnel; and
- Supporting investment in projects on postharvest in fruits and vegetables.

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