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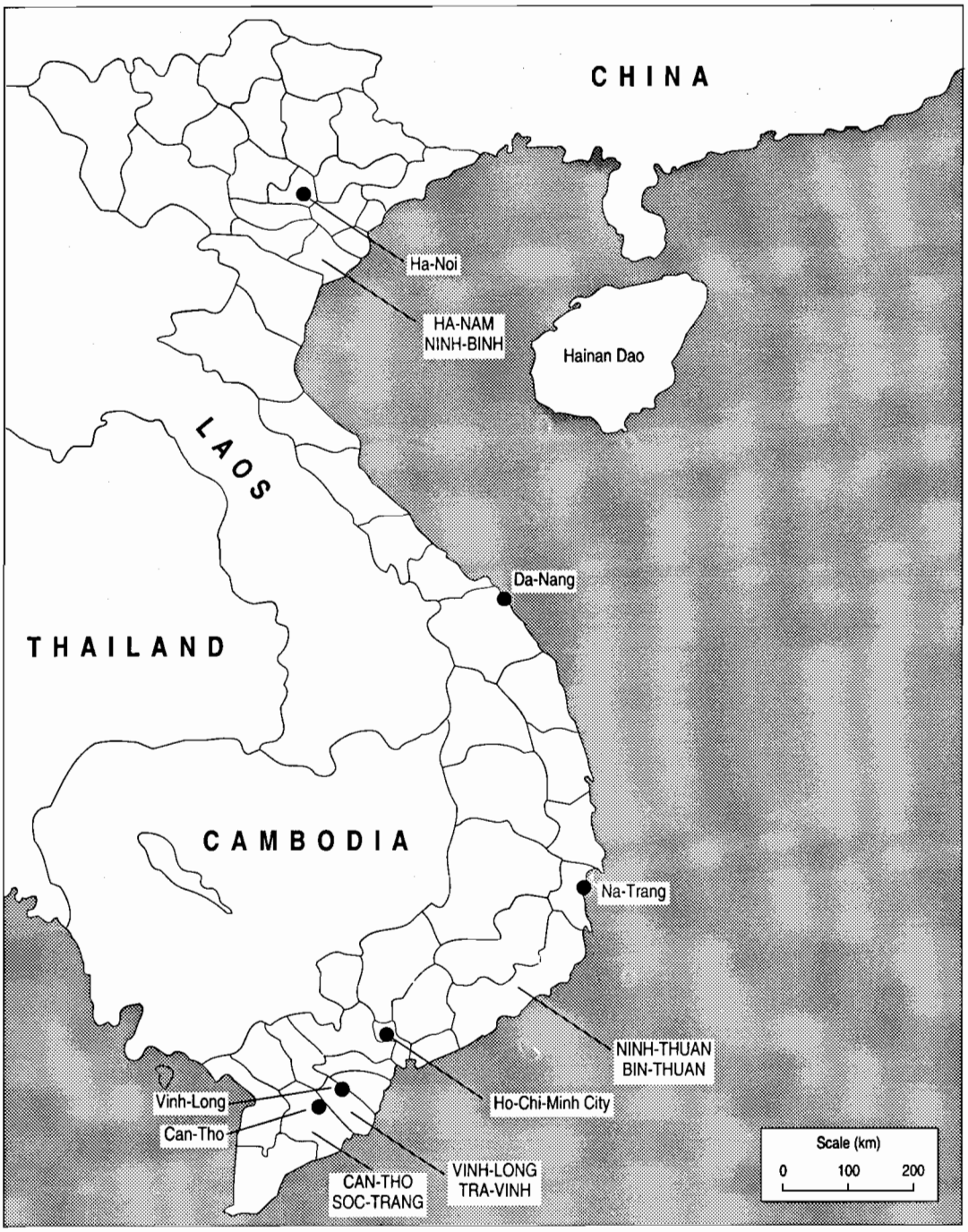
A Review of Food Research in Vietnam, with Emphasis on Postharvest Losses

My-Yen Lam

Australian Centre for International Agricultural Research
Canberra 1993



Vietnam, showing main agricultural provinces and centres

Contents

Acronyms and Abbreviations Used

AAACU	Asian Association of Agricultural Colleges and Universities
ACCT	Agence de Cooperation Culturelle et Technique
ADB	Asian Development Bank
AIDAB	Australian International Development Assistance Bureau
AIT	Asian Institute of Technology
AUSTRADE	Australian Trade Commission
BAD	Bank for Agricultural Development
BCI	Bank for Commerce and Industry
BIC	Bank for Investment and Construction
BFT	Bank for Foreign Trade
CIAT	Centro Internacional de Agricultura Tropical
CIDA	Centre d'Information et de Documentation en Agronomie
CIMMYT	Centro Internacional de Meijoramiento de Maiz y Trigo
CIP	Centro Internacional de la Papa
CLSU	Central Luzon State University
CMEA	Council for Mutual Economic Assistance
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTFT	Centre Technique Forestier Tropical des Chaud
EIB	Ecole Internationale de Bordeaux
ESCAP	Economic and Social Commission for Asia and the Pacific
FAO	Food and Agricultural Organization
FAO–RAPA	FAO Regional Agency for the Pacific and Asia
FCD	Fonds de Cooperation pour Developpement
FRI	Food Research Institute
HEKS	Hilfswerk der Evangelische Kirches der Schweiz
IAEA	International Atomic Energy Agency
IDRC	International Development Research Centre
IIRR	International Institute of Rural Reconstruction
INA	Institut National Agronomique
INRA	Institut National de Recherche Agronomique
IRAT	Institut de Recherches Agronomiques Tropicales
IRRI	International Rice Research Institute
ITC	International Trade Centre
MAFI	Ministry of Agriculture and Food Industry
SCS	State Committee for Sciences (now Ministry of Science, Technology and Environment) (Vietnam)
SUAN	South East Asian Universities Agro-ecosystem Network
SPC	State Planning Committee (Vietnam)
UCL	Université Catholique de Louvain
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
UNIDO	United Industrial Development Organization
UPLB	University of the Philippines at Los Baños
WHO	World Health Organization

Foreword

Vietnam is rapidly emerging from a long period of economic isolation from much of the rest of the world. Vietnamese authorities are well aware that, for the economy to grow and stabilise, the country needs to increase its trade with the rest of the world and that, initially at least, growth in exports will be in primary products.

The people of Vietnam have a long tradition in agriculture, which remains a major focus of social and economic activity. However, to expand into international markets, they will need to adopt, and adapt, new technologies in both production and postproduction phases of agriculture. Thus, as Vietnam rejoins the international community, many opportunities for linkages in research and development are emerging.

This report by a consultant, Dr My-Yen Lam, identifies where development assistance agencies such as ACIAR might best provide help to the postharvest subsector in Vietnam. It also gives wider information on food research, production, and handling that may be of value to food and agribusiness companies seeking to establish commercial partnerships with Vietnamese counterparts.

G.H.L. Rothschild
Director, ACIAR

Preface

THIS report is a result of work commissioned by the Australian Centre for International Agricultural Research (ACIAR) to review the needs for research into postharvest treatments to improve the quality and quantity of food in Vietnam. The report contains background information on methods of postharvest storage in Vietnam and how these methods could be upgraded to minimise loss of food and deterioration of quality. Details of the institutes, agencies, factories, facilities, and individuals visited and consulted by the author during a fact-finding mission to Vietnam are given in Appendixes 1 and 2.

Aims

The aims of the report are:

- To give an overview of the Vietnamese food industry with an emphasis on postharvest management.
- To determine the relative importance of agricultural and fisheries products in terms of their economic value.
- To identify which postharvest problems are associated with each product and to suggest possible ways of improving the value of each product.
- To determine the main reasons for food spoilage, wastage, loss of quality and inadequate marketing.
- To identify ways to improve quality so that the incomes of primary producers are maximised.
- To set guidelines for scientific work in regard to raw food and food preservation for Vietnam. This includes agricultural and fisheries products.
- To outline the structure of agricultural administration and research institutions in Vietnam so as to determine the most appropriate institutions for any postharvest projects.
- To contribute to the establishment of research linkages between Australia and Vietnam.

The report focuses on problems that:

- Have a high priority in Vietnam and in Australia.
- May be resolved and result in economic benefits.
- Can be addressed by Vietnamese scientific institutions with the capacity to undertake and/or participate in this work.

It is envisaged that this review will enable:

- Project proposals to be considered in terms of current conditions in Vietnam.
- A list of research projects to be developed in priority order.
- The establishment of closer relations with Vietnam, in terms of science, possibly leading to greater opportunities for commerce and trade.

The review identified the need for further developments which are beyond the scope of this report:

- The establishment of systems for benefit–cost analysis of research projects.
- The establishment of organisations and structures for long-term postharvest management.
- The provision of improved extension services to farming and fishing communities.

Outcomes

The review collected and interpreted data and identified the factors necessary for the minimisation of food losses in agricultural and fishery products in Vietnam.

The data collected covered the following:

- Information on importing and exporting countries.
- Information on import and export products.
- Quality control and the scientific input needed to implement and upgrade standards.
- Scientific work in progress in Vietnam to minimise food spoilage.
- Regulatory requirements for food control.

Benefits

The likely benefits of the research to Australia and Vietnam are:

- The provision of a clearer perspective on the opportunities for research to improve postharvest handling of produce in Vietnam.
- Improved postharvest management to minimise the current widespread wastage of food due to inadequate processing and storage.
- Improved cooperation with research projects on areas of mutual benefit.

The economic significance of these benefits is likely to be considerable because agriculture plays an important role in both Australia and Vietnam. It is estimated that, in Vietnam, up to 25% of total food production is lost after harvest. Minimisation of these losses would have a considerable economic impact.

Acknowledgments

THIS review of Vietnamese postharvest food activities was completed with friendly and helpful cooperation from many scientific institutions and individuals in both Vietnam and Australia. The many contacts established in Vietnam should be of great value in future cooperation in scientific developments between the two countries.

The author wishes to thank the personnel from all those organisations who cooperated in the compilation of this report. To name each individual and organisation is impractical but special thanks are extended to General Vo-Nguyen-Giap, the State Committee for Sciences, the Ministry of Agriculture and Food Industry, the Ministry of Fisheries, the Ministry of Forestry, the Ministry of Education and Training, the Ministry of Trade and Tourism, Provincial Peoples' Committees and Departments of Agriculture, the United Nations Development Program in Ho-Chi-Minh City, the Food and Agriculture Organization of the United Nations in Ha-Noi, the Stored Grain Research Laboratory in Canberra, and Victoria University and the Department of Agriculture in Victoria.

The author is also grateful to Mr Neil Menz for his editorial and technical advice.

Appreciation is also extended to Dr George Rothschild and ACIAR who gave the author the opportunity to contribute towards a closer liaison between Australia and Vietnam in agricultural research.

CHAPTER 1

Vietnam Profile

Background

Traditionally Vietnam has been a primary producer with more than sufficient food to feed its population. However, due to lack of advanced agricultural knowledge it has been unable to establish a significant export trade in primary products. The prolonged political turmoil and devastating war have exacerbated this.

With a relatively small improvement in agricultural technology in both production and preservation, Vietnam could dramatically increase its food supply.

Improvements in food quality and postharvest preservation would help to increase the quantity and value of food for human consumption. This is of paramount importance both for domestic consumption in Vietnam and for international trade.

Research is likely to be concentrated on the development of technologies relating to storage and preservation, causes of food spoilage, and economic analysis of various problems in different products, including fish. There is a need to prioritise the postharvest problems and to understand how they could be tackled and the role that Australia could play.

Due to the similarity in climate and the relatively short distance between Australia and Vietnam compared with the distances between America or European countries and Vietnam, the development of joint research and trading ventures between Australia and Vietnam will generate benefits for both countries.

Macro-environment

Government and national policy

Political system. The political system in Vietnam is a modified socialist republic and has been stable for more than 10 years.

Legal system. The legal system is well developed and comparable to western systems.

Banking system. Many banks operate in Vietnam: for example, EXI, Incom, Saigon, Vietcom, ANZ, Westpac, Banque Indosuez, Banque National de Paris, Bangkok, Banque Française du Commerce Exterer, Credit Lyonnase, Hong Kong and Shanghai Banking Corporation, Société Generale, Standard Chartered.

The Vietnamese dong (VND) is the official monetary unit, but the following currencies are used for trade: U.S. dollar, German mark, English pound, French franc, Swiss franc, Japanese yen, Hong Kong dollar.

Exchange rates for the Vietnamese dong at March 1992 are given in Table 1.

Table 1. Exchange rate for Vietnamese dong, March 1992

	Buying	Selling
Deutschemark	6 822	7 033
French franc	1 998	2 018
Hong Kong dollar	1 465	1 494
Japanese yen	84.01	87.51
Pound sterling	19 402	20 211
Swiss franc	7 529	7 765
U.S. dollar	11 420	11 520

Economic activity. In 1990 Vietnam's GDP was US$13 billion. During both 1990 and 1991 real GDP grew at an annual rate of 2.4%. In 1991 the value of exports was US$1.8 billion (Trade Development Council 1992: 34, 84). Gross material product for the period 1983–89 was approximately 85% of GDP (Table 2).

After a period of instability, the economic situation is currently stable. Agriculture remains the principal focus of economic activity, providing the main livelihood for about 70% of the people and generating more than 40% of the GDP.

Box 1 — Vietnam: Demographic Characteristics

Capital: Ha-Noi

Main city in South Vietnam: Ho-Chi-Minh City

Population (1990): 66 million

Working population (16 years of age and over): 27.5 million

Agricultural workers:
- Total 19.8 million
- Percent of total population: 30
- Percent of working population: 72

Location: Between latitude 23°33'N and 8°30'N, and longitude 102°10'E and 100°3'E

Neighbouring countries: China, Laos, Cambodia

Area: 332 000 km^2

Length: 1650 km from north to south

Width: 600 km at widest point and 50 km at narrowest area from east to west

Length of borders: 3730 km

Length of coastline: 3260 km

Climate: Tropical

North: Four seasons, winter 0–12°C, summer 32–38°C
Humidity: 60–100%

South: 22–33°C
Humidity 76–86%

Appendixes 4 and 5 contain detailed temperature and rainfall figures.

Official language: Vietnamese. English is used as one of the most important second languages, most children are taught English at school.

Education system:

Labour skills are relatively high due to good education, and training schools.
Management skills are being improved by programs to send students overseas to study management.
Training is given a high priority in Vietnam and many training institutes have been established.

Administrative levels:

In Vietnam there are two administrative levels, central and local. The central level is comprised of the Council of Ministers, committees, department and institutes. The local level is divided into provinces, districts and communities.

Regions and provinces: Vietnam is divided into seven regions and is further sub-divided into a total of 53 provinces. In 1990 Vietnam consisted of 44 provinces due to the fact that in some cases two provinces were merged into one. In December 1991, the provinces previously merged were re-divided.

Appendix 3 contains data on the area, population and density of each province.

Industry accounts for almost 25% of GDP and in recent years Vietnam has been concentrating on the development of light industries, including cottage industries. Economic reforms have resulted in the establishment of more than 100 000 private businesses involved in manufacturing, retailing and services. These businesses employ over 3.8 million people (13.8% of the labour force).

In 1991, over 200 000 overseas tourists visited Vietnam. The tourist industry has great potential for development. The arrival of tourists creates a demand for processed food which could be of benefit in developing and expanding a food processing industry.

The development of Vietnam's offshore oil reserves should be of great economic value in the near future.

Table 2. Percentage distribution of gross material product, 1983 and 1989

	1983	1989
Agriculture	45.0	41.1
Industry	21.8	24.3
Commerce	11.9	12.2
Construction	2.4	2.2
Transport and communication	1.5	1.5
Other	2.2	3.4

Source: UNIDO 1991: vii.

International trade

Major trade agreements. Trade agreements with foreign countries were signed in May 1990 and the Investment Protection Agreement was created in March 1991.

Investment, taxation and duties. The investment laws implemented in 1988 to protect the interests of foreign investors seem to be the simplest in Asia. They allow joint ventures with 100% ownership. No import or export duties are applicable. There is a four-year tax exemption for manufacturers and a two-year exemption for the service sector. Investors are permitted to recruit and employ their own workers.

Commodity trade. Vietnam has been a member of the Council for Mutual Economic Assistance (CMEA) since 1978. By 1989 Vietnam had 50% of its trade links with CMEA and 40% with democratic countries including Hong Kong, Singapore, Japan, South Korea and Western European countries. Although Japan was the largest non-CMEA trading partner it has now been overtaken by Singapore (Tables 3–5).

In 1991, barter trade with the former USSR was cut seriously, trade with Eastern block countries declined by 23% but increased with Japan, Singapore, Taiwan, Thailand, Hong Kong, France, Italy, U.K. and Australia.

In 1991, the United States and Vietnam negotiated for the normalisation of relations. China and Vietnam also resumed diplomatic relations after 13 years of conflict.

Imports in 1989 were estimated at around US$2.5 billion. Half of these came from non-socialist countries. The majority of these imports were machinery, semi-manufactured goods and raw materials needed for the nation's development. Consumer goods accounted for less than 20%.

Table 3. Exports and imports as a percentage of GDP, 1988–90

	1988	1989	1990
Exports	9.1	16.9	18.8
Imports	32.4	28.5	29.9

Source: General Statistical Office 1992: 188.

Table 4. Numbers of Vietnam's trading partners by region, 1987–90

	1987	1988	1989	1990
Total	35	45	41	53
Export (to Vietnam)	35	37	33	42
Import (from Vietnam)	32	40	39	51
Of which:				
Asia	14	19	16	21
Export	13	12	13	16
Import	12	17	16	19
Europe	18	21	19	24
Export	18	21	16	20
Import	16	17	17	21
Africa	–	2	3	3
Export	–	1	1	1
Import	–	2	2	3
America	2	2	2	4
Export	2	1	2	3
Import	2	2	2	4
Australia and Oceania	1	1	1	1
Export	1	1	1	1
Import	1	1	1	1

Source: General Statistical Office 1992: 189.

Table 5. Exports of primary produce, 1988–91

	1988	1989	1990	1991
Agriculture				
Value (US$m)	349.2	706.6	783.2	640.3
Share (%)	33.6	36.3	32.5	32.4
Fisheries				
Value (US$m)	178.0	206.2	239.0	267.0
Share (%)	17.1	10.5	9.9	13.5
Forestry				
Value (US$m)	59.2	111.0	126.5	102.4
Share (%)	5.7	5.7	5.3	5.0

Source: General Statistical Office 1992: 202,3.

Main export products include crude oil, minerals, scrap iron, coal, textiles, seafood, rice, agricultural products, handicrafts, and light industrial products (Table 6).

Table 6. Exports by commodity, January–June 1992 (US$ million)

Rice	77.6
Soybean and other beans	25.7
Coffee	16.6
Pepper	6.6
Frozen meat	0.5
Seafood	49.0
Forestry products	15.5
Light industry	29.6

Source: Tuoi-Tre, 25 June 1992.

Joint venture projects. Some 200–300 foreign trade organisations, including large manufacturing enterprises, are authorised to conduct trade in Vietnam (Table 7). By 1989 Vietnam had 106 joint venture projects involving US$850 million. In June 1991, there were 273 projects amounting to US$2 billion investment. In early 1992, there were 363 projects amounting to an investment of US$2.7 billion. Main partners include: Taiwan (with total investments of US$603 million in 46 projects); and Hong Kong (US$394 million in 90 projects). Major investments are in oil exploitation, hotels, tourism, prawn farming, food processing and manufacturing of light consumer goods.

International cooperation

In 1988 UNDP, FAO, UNIDO, and WHO were administering a total of 300 projects in Vietnam (Appendix 39). Since 1977, FAO has emphasised the need to prevent postharvest agricultural losses, and projects have been funded in an effort to reduce losses at both the farm and village level. Box 2 describes several projects relating to postharvest losses.

Vietnam's relationship with Australia

Trade links between Australia and Vietnam have increased steadily since 1984 and it is expected that these will increase dramatically in the 1990s (Tables 8 and 9).

The Australian Trade Commission (AUSTRADE) has opened offices in Vietnam because an increasing number of Australian companies are interested in doing business in the country. Telecom Australia has established a communication centre in Ho-Chi-Minh City to assist the world in its communication with Vietnam.

Up until 1987 only about 200 people per year went to Vietnam from Australia, compared with over 30 000 people today. Qantas has established direct flights from Australia to Ho-Chi-Minh City.

BHP will invest some US$2 billion in developing Vietnam's offshore oil, and other large companies including Australia's OTC and ANZ have branches in Vietnam.

Apart from America, which is geographically distant from Vietnam, Australia is the only industrial country with a climate similar to that of Vietnam's. Australia could be involved in trade with Vietnam in the areas of food processing and packaging.

Administrative System

In Vietnam, Parliament is responsible for policy making and the government for its implementation.

At the central government level, the Council of Ministers and the State Planning Committee (SPC) are the main decision-making parties. The State Committee for Cooperation and Investment

Table 7. Joint venture projects, 1989–92 (US$ million)

	1989		1991		1992	
	Number	Amount	Number	Amount	Number	Amount
Total	106	850	273	2000	363	2700
Taiwan			32	439	46	603
Hong Kong			68	230	90	394
Australia			16	278		
France			25	272		

Source: Trade Development Council 1992: 34,84.

Box 2 — Projects relating to postharvest losses

FAO (1979)

Project: PFL/VIE/001 (phase I).
Started: December 1979.
Title: Prevention of food losses program.
Objective: To minimise the loss of rice after harvesting. The loss of rice was due to inadequate milling and lack of satisfactory storage facilities in Minh-Hai Province.
Funding: US$200 000.

The Netherlands

Project: GCPP/VIE/008/NET (phase II).
Duration: Continuation of phase I, completed in March 1983.
Title: Action program for the prevention of food losses.
Objectives:
- To improve storage facilities in specified rice mills by providing construction materials.
- To equip four secondary warehouses in rural areas with small-capacity storage facilities.
- To reduce transport problems.
- To conduct practical training courses for technical staff of the Rice Milling Enterprise and the Food Department in Rice Milling and Storage.

Funding: US$243 900.

Funding by UNDP and implementation by FAO (1979)

Project: VIE80014D0112.
Duration: Four years (from 1980 to 1985).
Title: Postharvest protection of agricultural food products.
Objectives:
- To increase availability of rice through reduction of postharvest losses occurring in the procurement, transportation, processing and storage operations.
- To demonstrate the effectiveness of improved methodology and technology in the reduction of postharvest losses through a pilot scheme which covered handling, procurement, drying, storage and processing at village, district, provincial and regional levels.
- To strengthen the Food Research Institute (FRI) in Ha-Noi through the provision of research equipment, technical assistance and fellowships.
- To provide assistance in the establishment of a field station of the FRI in Tra-Noc, Hau-Giang province.
- To assist FRI in the organisation and conducting of training courses to meet the specific needs of the country in the postharvest sector.

Activities:
- The objectives of the project were to be achieved by the upgrading of the paddy storage and processing centre at Tra-Noc. The project provided mechanical handling facilities for paddy so as to reduce waiting times prior to transportation. Drying facilities for paddy to reduce its moisture content to a safe level using husk as fuel were included in the project. The necessary cleaning, weighing and handling equipment was also provided.
- The FRI at Ha-Noi was relocated to a more spacious area. Two field stations were established during 1980–85, one at Ho-Chi-Minh City, the other at Tra-Noc.
- The project provided fellowships, consultant services and equipment for FRI in Ha-Noi and for the field station at Tra-Noc.
- The project included training for a 150 people at university level. About 1000 technicians and operators were trained at secondary/vocational level.

Funding: US$3 million.

FAO (1988)

Project: VIE88033.
Duration: February–April 1989.
Title: Agricultural and food production sector review.
Collaborating institutions: A group of 12 people from FAO, World Bank, and consultants from Rome. The Vietnamesecounterpart team included the State Planning Committee, the Ministry of Agriculture and Food Industry, the Ministry of Fishery and the State Statistic Bureau.

Table 8. Exports from Vietnam to Australia, 1988–90

	1988		1989		1990	
	Quantity (tonnes)	Value (US$'000)	Quantity (tonnes)	Value (US$'000)	Quantity (tonnes)	Value (US$'000)
Coal	–	–	2,454	111	–	–
Fine art	–	4	–	7	–	17
Pepper	50	133	–	–	–	–
Prawns	279	2014	–	–	126	1095
Fish	267	655	–	–	310	647
Others	1	1,113	–	502	0.4	70
Total	–	3930	–	793	–	2290

Source: General Statistical Office 1992: 384–385.

Table 9. Imports to Vietnam from Australia 1988–90 (US$'000)

	1988	1989	1990
Rubber[a]	–	–	144
Medicine[a]	–	–	727
Cigarettes[a]	–	95	702
Medicaments	413	160	–
Total	462	255	1573

[a] Catalyst or additive for processing.
Source: General Statistical Office 1992: 468–469.

(SCCI) has responsibility for cooperation and investment, particularly with foreign countries. The State Committee for Sciences (SCS) has responsibility for coordination of research and technology transfer.

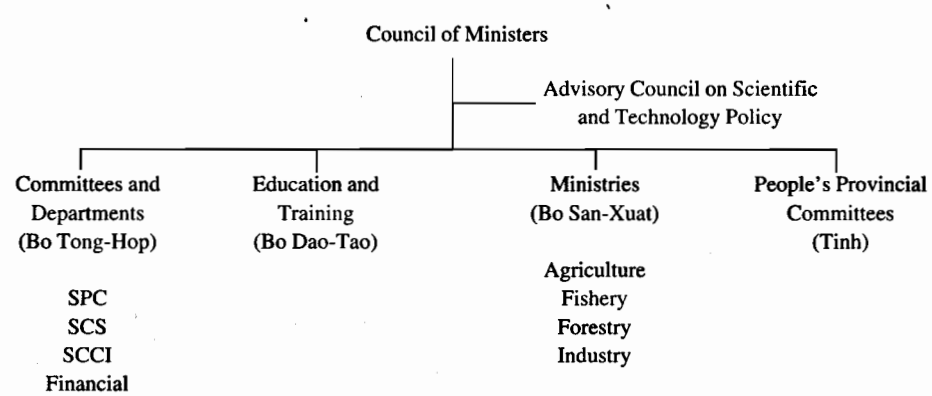
In November 1992, SCS changed its name to the Ministry of Science, Technology and Environment, and added an environment sector.

Committees

State Planning Committee (SPC)

The Scientific and Technology Department of the SPC is responsible for planning and coordinating the roles of various subsectors of science and technology to fit in with the broader macroeconomy. SPC also plays the major role in allocating the budget and the level of resources to be invested in research.

Administrative structures relevant to agriculture



International cooperation issues may be handled by the Council of Ministers, SPC and SCS. Official development assistance is the responsibility of the SPC and Council of Ministers because it involves matters affecting the economy at the national level.

State Committee for Sciences (SCS) or Ministry of Science Technology and Environment

The functions of SCS include:

- long-term and short-term priority setting.
  - establishing procedures
  - setting general directions for research at a national level, including agriculture;
- financial planning and budget allocation
  - to commission research studies by institutions at the government level
  - allocation of financial resources for scientific projects; and
- policy making
  - industrial patents
  - standards and regulatory issues
  - international cooperation in science and technology
  - science and technology information gathering.

Ministries

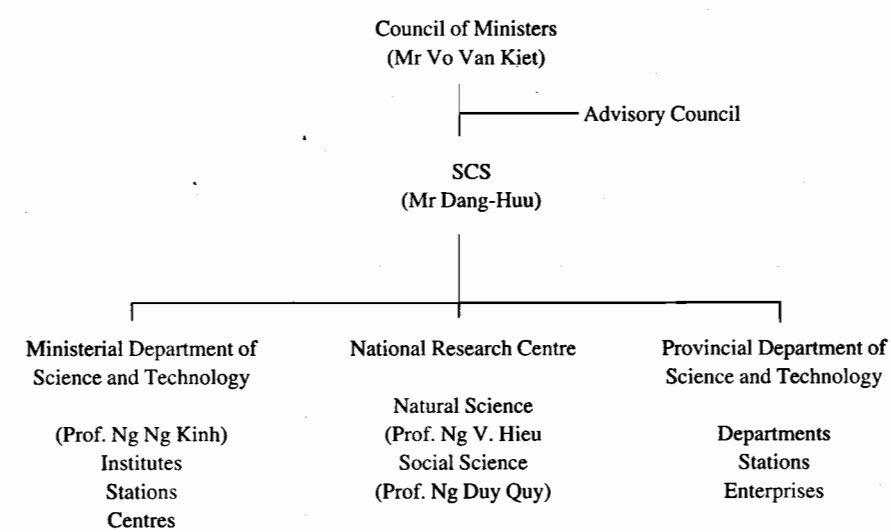
Ministries responsible for different aspects of food, health and international corporations:

Ministry of Agriculture and Food Industry (MAFI)
Ministry of Fisheries
Ministry of Forestry
Ministry of Health
Ministry of Education and Training
Ministry of Foreign Affairs
Ministry of Home Affairs

Institutes and centres of the Ministry of Agriculture and Food Industry:

Agricultural Science Institute of Vietnam (Ha-Tay)
Agricultural Tools and Mechanisation Institute (Dong-Da, Ha-Noi)
Agricultural Architecture Design Institute (Dong-Da, Ha-Noi)
Agricultural Science Institute of South Vietnam (Ho-Chi-Minh City)
Biology Institute, National Centre of Scientific Research (Ha-Noi)
Biotechnology Centre, Ho-Chi-Minh City Branch of National Centre of Scientific Research (Ho-Chi-Minh City)
Breeding Technology Institute (Tu-Liem, Ha-Noi)
Centre for Research and Development of Farm Engineering (Ho-Chi-Minh City)
Food Industry Engineering Institute (Nguyen-Trai, Ha-Noi)
Institute of Cattle Breeding (Tu-Liem, Ha-Noi)

Relationship of SCS to other bodies



Institute of Fruit-tree and Industrial Crop Research (Phong-Chau, Vinh-Phu)
Institute of Materia Medica (Pharmaceutical materials) (Ha-Noi)
Institute of Food Crops (Tu-Loc, Hai-Hung)
Institute of Agricultural Economic (Nguyen Cong-Tru, Ha-Noi)
Institute of Agricultural Land Planning and Arrangement (Ha-Noi)
Maize Research Institute (Dan-Phuong, Ha-Tay)
Mekong Delta Rice Research Institute (O-Mon, Hau-Giang)
Paedology and Agro-chemistry Institute (Tu-Liem, Ha-Noi)
Plant Protection Research Institute (Tu-Liem, Ha-Noi)
Postharvest Technology Institute (Ha-Noi)
Postharvest Technology Sub-Institute (Ho-Chi-Minh City)
Rubber Economic–Technological Institute (Ho-Chi-Minh City)
Seed Varieties Experimentation Centre (Ha-Noi)
Sericulture Research Institute (Gia-Lam, Ha-Noi)
Sericulture Experimentation Centre (Bao-Loc, Lam-Dong)
Tea Research Institute (Vinh-Phu)
Tobacco Research Institute (Ha-Noi)
Vegetable & Fruit Research Institute
Veterinary Research Institute (Dong-Da, Ha-Noi)

Institutes of the Ministry of Fisheries:

Institute of Marine Products Research (Hai-Phong)
Centre for Research on Inland Aquatic Products (Tien-Son, Ha-Bac)
Institute of Marine Research (Nha-Trang)

Universities involved in agriculture:

University of Sciences and Technology (Ha-Noi)
University of Forestry (Ha-Noi)
University of Agriculture 1 (Ha-Noi)
University of Agriculture 2 (Bac-Thai)
University of Agriculture and Forestry 3 (Hue)
University of Agriculture and Forestry 4 (Ho-Chi-Minh City)
University of Can-Tho (Can-Tho)
University of Da-Lat (Da-Lat)
University of Fisheries (Nha-Trang)

Hierarchy of departments (Council of Ministers) in agriculture at national and local levels:

National Department of Agriculture

↓

Provincial Department of Agriculture

↓

District Department of Agriculture

Hierarchy of enterprises (commercial activities):

Ministry of Agriculture

↓

General company (in terms of science and technology)

↓

Local company

Grade I: Production controlled by ministry
Grade II: Production controlled by province
Grade III: Production controlled by local township

A list of the institutions and universities contacted in the course of this review is given in Appendix 2.

The formation of a network of scientific organisations with the capacity to be involved in projects relating to postharvest research throughout Vietnam would be highly desirable. An outline of the structure and functions of universities and scientific institutions which could form this network is included in Appendix 40. Most of these universities and institutions are currently involved in international aid programs.

CHAPTER 2

Agriculture Profile

Nine million hectares of land are used for agricultural purposes, of which 7 million ha, 21.2% of the country's total area, are used for food crops. Rice is grown on 6.3 million ha, maize 0.43 million ha, sweet potatoes 0.35 million ha, cassava 0.27 million ha, peanuts 0.2 million ha and sugarcane 0.15 million ha.

Agricultural Regions

Northern regions

The northern part of the country (formerly North Vietnam) is divided into three agricultural regions.

North Montane and Midland occupies 9.8 million ha (30% of the country's area) and comprises a large area of poor, infertile, light-coloured soil, with mountains, plateaus and hilly midlands. Elevation range is 100–3140 m above sea level. The wet season occurs from mid-April to early November. Mean annual rainfall range is 1600–2500 mm and the region is cold from December to March.

Tea, coffee, peanuts, cassava, mulberries, maize, and buffalo are farmed. Tea is the main crop and accounts for some 60% of the region's production. Only 9% of the total area is forested. Deforestation and subsequent soil erosion, which is estimated to occur on 80% of the total area, are serious problems to further agricultural development. A conservation strategy is needed to prevent deterioration of the ecological balance. Orchards and pastures could prove to be economical and ecologically beneficial.

The population of this region is 11 million and includes about 3 million tribal minorities. Average population density is 109 people per km^2.

Red River Delta occupies 1 million ha (3.8% of the country's area) and comprises the most fertile northern soils.

Elevation is generally just a few metres above sea level. From late July to early August, the Red River water level can be over 14 m above the plain level due to high silt loads of the rivers from the North Montane region. The wet season occurs from April to early November. The mean annual rainfall is around 1700 mm.

Some 90% of this region is cultivated, but minor land degeneration has occurred due to intensive cultivation without use of adequate fertilisers. Main agricultural products are rice, maize, sweet potatoes, cassava and pigs. Average paddy yield is around 6 t/ha from two crops (spring and summer).

Population is 13 million with a density of over 1000 people per km^2. Over-population is a concern.

Central Coast occupies 5.2 million ha which is 15.7% of the country's area. This area consists of hills and mountains with elevations ranging from 100 to 2710 m above sea level. There are also narrow coastal deltas, sand dunes and estuarine flats which account for about 20% of the total area. This region lies in a typhoon belt, and is subject to storms and torrential rain. The wet season occurs between April and December, and this region is the wettest part of Vietnam. Mean annual rainfall is 2890 mm. Mean annual temperature is 25.3°C. Around 90% of the coastal lowlands are affected by salinity or alkalinity which limits rice production during the wet summer season.

Main agricultural products include: rice, maize, coconuts, peanuts, kenaf flower, citrus fruits, pineapples, peppers, cattle and buffalo.

Population is about 8.8 million, and density is 173 people per km^2.

Southern regions

The southern part of the country, formerly South Vietnam, is divided into a further four regions.

Central Coast. This region occupies around 4.6 million ha which is 13.9% of the country's area. The topography is similar to that of the North Central Coast but has 10% more lowland. Most of the hilly and mountainous areas are severely eroded as a result of deforestation. This is the driest area of Vietnam having a mean annual rainfall of less than 1000 mm. The mean annual temperature is around 26°C.

Whilst the lowlands are intensively used for wet rice cultivation, coffee and tea are the principal crops on plateaus 1000 m or more above sea level. The full cultivation potential of the uplands has not yet been adequately met. Sand dune encroachment due to high salinity and alkalinity, restricts cultivation to one rice crop per annum.

The population is 6.8 million, and population density 149 people per km^2.

Central Highlands occupies around 5.5 million ha (16.6% of the country's area). Peaks of mountains are 2600 m above sea level but the altitude of most of the area is about 1000 m. The rainy season occurs from April to October. Mean annual rainfall is around 2280 mm. The mean annual temperature is 21–23°C.

Rice cultivation occupies 143 000 ha, of which 116 000 ha are terraced fields. The area devoted to growing rice could be expanded 2–3 times over the current level. The highlands have excellent conditions for cultivation of perennial industrial crops and have the potential for further expansion.

Main agricultural products are rice, maize, vegetables, coffee, tea, rubber, mulberries and cows' milk.

Population is 2.6 million with a density of 47 people per km^2.

North East occupies 2.3 million ha (7% of the country's area). Rice crops occupy 257 000 ha.

Elevation ranges between 100 and 1000 m above sea level, but the majority of the region is below 400 m. The rainy season is between April and October. The mean annual rainfall is around 2000 mm. The mean annual temperature is 26°C.

This region is very good for industrial crops and orchards. The main products are rubber, maize, peanuts, soybean, cassava, orange, mango, pineapple and avocado.

Land deterioration and damage caused by war has had adverse effects on the fertility of this area.

The population is 8 million, and the population density 340 people per km^2.

Mekong River Delta occupies 4 million ha (12.1% of the country's area). Elevation is generally below 10 m above sea level. Mean annual rainfall is around 2000 mm most falling between June and November. The mean annual temperature is 26– 27°C.

This is the largest rice-producing area in Vietnam and currently accounts for 45% of Vietnam's annual rice production. The Mekong Delta is an excellent environment for aquaculture development, particularly for prawns and fish. Apart from rice, the main agricultural products are coconuts, fruit, vegetables, beans, pigs, ducks and cows' milk.

Of the cultivated land, 40% has been subject to acid sulphate soil spoilage. Salinity is another problem and it is estimated that up to 700 000 ha of saline land could be reclaimed for agricultural purposes if sea water intrusion could be prevented.

The population is 14.6 million and the density 370 people per km^2.

Marine Resources

Vietnam has a long coastline of 3260 km with over 100 river mouths and more than 3000 islands.

About 50% of Vietnam's provinces and cities are located along the coastline, with 110 coastal districts. The economic infrastructure is based on sea products, but the marine ecosystem has not been used to its maximum potential. About 1 million people are fully engaged in fisheries activities: 0.8 million in marine fisheries, of which 290 000 are directly engaged in catching activities. Currently about one-third of the young fish farmers reaching working age are unemployed.

Freshwater Resources

Vietnam has abundant water resources. Over 1.2 million ha of surface water is widely distributed throughout the country:

- 2860 rivers and canals with an area of 653 600 ha
- lakes and ponds covering 450 000 ha
- marshlands occupying 85 000 ha.

Climate

Vietnam usually has 7–10 major storms each year. Natural disasters such as storms, floods and cold winds cause the loss of over 300 000 t of food a year.

Apart from storms and floods, pests and diseases have also caused serious damage to

many Vietnamese crops. Every year about 10% of the area under food cultivation is destroyed by pests.

In 1991 in the southern regions of the country, about 200 000 t of winter–spring rice was lost because of pest infestation. This represented a decrease in yield of about 2%. In the north, pests and diseases combined with unfavourable weather to cause the loss of over 1 million t of rice.

Within the 15-year period 1975–1990, there have been at least four serious natural disasters that have each accounted for a major loss of food: 1977, 880 000 t; 1978, 780 000 t; 1987, 820 000 t; and 1991, 1.3 million t.

CHAPTER 3

Major Agricultural Provinces

Vinh-Long

Population:	1 million
Area:	148 900 ha
Agricultural area:	117 000 ha
Fully cultivated, devoted mainly to	
Rice:	85 000 ha
Orchards:	27 000 ha
Vegetables:	5 000 ha

Salt-free river water resources 7 000 ha, with rich silt topsoil that is fertile all year round.

Major agricultural products

The main food crops include rice, sugarcane, coconuts, maize, cassava, beans, sweet potato, potato, peanuts, fruits and vegetables.

Rice

In 1991, 720 000 t of rice were harvested, and 760 000 t in 1992. Average yield is 3.8–4 t/ha, although some varieties yield 7– 8 t/ha.

Proposed production for 1995 is 860 000 t, of which 400 000 t will be used for domestic consumption and animal feed, and 460 000 t will be exported.

There are three harvesting seasons in Vietnam:

- spring rice (winter–spring rice)
- autumn rice (summer–autumn rice)
- winter rice (monsoon rice).

Table 10 contains information on harvesting time and quantities of rice dried.

The total amount of rice dried in Vinh-Long in 1991 was 720 000 t. Of this, about 220 000 t were harvested in the rainy season (August–November).

Every July there is a short drought, which is used by the people to harvest and dry their paddy on the roadways. However, the harvesting of August and of winter-rice is during the rainy season and people have to deal with the rain when trying to dry their grain. Harvest losses are estimated at over 20% at this stage.

Orchards

The total area under orchards in the province of Vinh-Long is 27 000 ha. Tam-Binh, Binh-Minh, and Long-Ho are the best fruit-producing areas in the province.

Main fruit crops are bananas, guava, watermelon, oranges, mandarin, pomelo, mango, longan, mangosteen, milk fruit, pineapple and jack fruit.

Yields for longan are 20 t/ha and for pomelo, 7 t/ha.

Table 10. Quantity of rice dried in Vinh-Long, 1991

	February–April	June–August	September–November
		August–November rainy	
Rice season	Spring–rice	Autumn–rice	Winter–rice
Area (ha)	70 000	70 000	16 000
Yield (t/ha)	5.8	3.7	3.5
Total (t)	406 000	259 000	56 000

During the past 2–3 years, there has been a tendency to replace rice fields with orchards, e.g. Tan-Binh's orchard areas have increased from over 3000 ha to 6000 ha.

Coconut

Vinh-Long has 3 million coconut trees. The average yield of each tree is 50 coconuts, giving a total production of 150 million coconuts annually.

The production of coconuts has fallen since the introduction of the tax-free policy for palm oil. Many farmers have begun to remove their coconut trees.

Livestock

Pig production is 150000 animals per year (average weight about 90 kg); poultry, 3 million birds; and ducks, 8–10 million birds. Only duck eggs and down are exported, no markets for meat existing at this stage.

Animal production in conjunction with orchards is developing well and in recent years has increased steadily. From 1987–1990 production of livestock rose by 5%, and from 1990–1992 by a further 15%.

An adequate quarantine system is in place, but there is a need for meat-processing technology and facilities. Attempts have been made to combine meat processing with seafood processing but results have not been favourable.

Fisheries

There are large prawn breeding areas (8000 ha) mainly along the Tien and Hau rivers, but Vinh-Long does not have industrial-scale aquaculture. Each facility produces 4–5000 t of giant green prawn *(Machrobrachium rosenbergii).*

The province has a fish-breeding farm with an area of 40 ha, in which there are more than 27 ha of fish ponds.

A seafood processing company was established in 1980, but its machinery is now out-of-date.

Extension

Vinh-Long has an extension centre, established in April 1990, which puts most emphasis on rice. There are 45 extension engineers, the centre's activities concentrating on farm visiting, consulting with farmers, collecting productivity data, exchanging knowledge and experiences with farmers, discussion, displaying and training. The local agricultural club, radio and a video are used to facilitate communication.

Tra-Vinh

Population:	800 000
Household units:	158 000 families
Agricultural labour:	333 000 people (84%)
Product value (GDP):	US$68 million
Ratio of agricultural products to total production:	61%
Area:	236 900 ha
Agricultural area:	148 700 ha (63%)

Soil characteristics: coastal plain
28% of the area is sulfate soil
70% of the area is contaminated with seawater
13% (20 000 ha) of the cultivated land is irrigated, the remainder depends on rain water
Weather patterns in Tra-Vinh are highly variable
Coastal forests (25 000 ha) are often flooded with seawater. Due to unplanned deforestation this area has became poor.

Main agricultural products

Rice

The cultivated area of rice is 117 000 ha (79% of farm land). Rice production in 1991 was 527 000 t, of which 300 000 t were consumed locally.

Coconuts

The area under coconut is 7400 ha and there are about 5.5 million trees. In a good season copra production can amount to 22000 t. Coconut oil exports are about 2000 t/year.

There is currently no export market for coconut products, and the crop is exported as raw material, i.e. dry copra, desiccated coconut. The province is unable to sell coconut oil because of the collapse of the markets in the former USSR and Eastern Europe.

Orchards

Area under orchards amounts to 16680 ha and there is abundant production of citrus fruit, guava, watermelon, etc. There is a need to establish export markets.

Sugarcane

Crude sugar production in 1991 was 70000 t. Poor world prices have led to the removal of plantations and a significant decrease in production.

Other crops

Main crops are maize, sweet potato, beans, tobacco, peanuts, cashew nuts, pumpkin, tomato, herbs, bitter melon, shallots and cucumber. These crops are abundant and exhibit a wide variety. Cultivated area is 7000 ha.

Cottage industries

Cottage industries include rice processing (noodles, vermicelli, rice liquor); yeast for rice liquor (using by-products for pig feed); and sugarcane processing products (sugar, candy and beverages). However, local sugar (mainly brown sugar) is considered inferior to refined imported sugar.

Livestock

The province has 136 000 pigs, 72 000 cattle and 4.5 million poultry birds.

Fisheries

Aquaculture facilities provide 23000 ha for prawn breeding. Production is 10000 t/year and 1100 t/year of frozen prawns are exported.

Although Tra-Vinh possesses 11 boats, these are grossly underutilised. Marine production is 30–40 t/ year, but currently there are insufficient outlets to sell the catch.

The only processing of prawns which takes place is peeling and freezing.

Infrastructure

Tam-Phuong irrigation system

Completed in 1985, with joint Australian and Vietnamese Government support, this irrigation system covers an area of 6000 ha, of which 4000 ha can be cultivated for two crops a year, and 1000 ha for three crops a year. Annual cultivated areas have risen from 136870 ha in 1985 to 148000 ha in 1991. Production of rice has risen over 1.5 times, from 349 200 to 527 000 t/year.

Satake milling company

This mill belongs to the district and town and has a capacity of 5 t/hour. The company buys only high quality rice and is able to achieve output at the specification of 5% of broken rice in about 45% of its overall production.

Summer–autumn rice does not meet export standard and some consideration needs to be given to the replacement of rice varieties.

Tra-Vinh has another 540 small-scale private milling plants with a total capacity of 140 t/ day, and also a number of private processing companies.

Tra-Vinh vegetable oil factory

The factory produces 9000 t/year of unrefined oil, which is refined in town for edible oils.

Exports of 2000 t of coconut oil are made each year.

Seafood factories

There are two seafood-processing factories in the province.

General status of rural sector

- Availability of land and labour resources are still high.
- Production is small scale, inefficient.
- Yield of rice: 3.2 t/ha (average yield in Mekong River Delta region is about 4.5 t/ha).
- Yield of maize: 1.1 t/ha (average yield in the region is about 3 t/ha).
- Yield of sugarcane: 40 t/ha (average yield in the region is about 60 t/ha).
- Level of land utilisation: low, ratio of land rotation is about 1.26 times/year (average ratio of land rotation in the region is 1.6–2 times/year).
- Technology capacity is poor.
- Numbers of livestock are small.
- Postharvest handling — no drying facilities therefore have to sun dry, often with serious losses of quality as well as quantity.
- Poor storage facilities leading to heavy losses.
- Crop species and cultivars are mainly local, many of them susceptible to pests and diseases.
- There are only a few dryers in the province, labour is very cheap and farmers cannot afford to buy dryers.
- To promote mechanisation, it is suggested that model villages and extension groups be estab-

lished to help convey to farmers the long-term benefits of good postharvest policy. Tra-Vinh is a complex province and extension and training needs to be specific for each locality.

- Varieties of rice that can be grown in sulphate soils are not usually suitable for export. It is not practical to introduce new cultivars without irrigation. Current production is 500000 t/year. This could be expanded to 1 million t a year with irrigation.

Current constraints

- Lack of funds.
- Cost of providing one hectare of rice is about US$300
- Capacity to produce rice differs from one locality to another.
- Market still unstable.

Can-Tho

Population:	280 000
Households:	42 150 families
Labour force:	138 000 (about 50% of the population)
Employment by sector:	
Agricultural	32%
Industrial	10.5%
Business, services and others	57.5%
Land area:	220 000 ha
Rice areas:	180 000 ha
Orchard areas:	30 000 ha
Border:	140 km
Neighbouring provinces:	An-Giang, Soc-Trang, Vinh-Long, Kien-Giang
Temperature:	Average 27°C Range 17.8–37.6°C
Relative humidity:	Average 82% Range 76–86%
Rainy season:	May–November
Number of rainy days per year:	120–140
Wind: dry season	North-east
wet season	South-west
Average wind velocity:	3–3.8 m/sec.
Maximum wind velocity: (Can-Tho has experienced very few typhoons or strong winds.)	30 m/sec.
Sunshine: radiation energy	6–12.3 kcal/cm^2
Total radiation per year	ca. 100 kcal/cm^2

Main agricultural products

Rice

Rice production is some 1.3 million t/ year, of which 600 000 t are surplus to local needs. Efficient storage facilities are needed. Postharvest losses are estimated to be 15–20%; due mainly to inadequate drying and poor storage.

Weed control is effective and rodent and bird damage are insignificant.

Coconut oil

30 000 t/year of coconut oil are produced.

Pineapples

The produce is handled at a freezing factory with a capacity of 6000 t/year.

Sugarcane

Sugarcane is grown over an area of 100 000 ha, but only raw sugar is produced.

Livestock

The province has 170000 pigs; 2.2 million poultry birds (for domestic consumption only); and a few cattle in Can-Tho and the Mekong Delta.

The province is planning to establish a meat freezing plant of 10 000 t/year.

Fisheries

Can-Tho has a prawn processing plant.

Extension

Extension services began in 1977 and are active in the provinces of Hau-Giang, Cuu-Long, An-Giang and Minh-Hai.

Every year contact is made with over 100 groups of farmers, and questions are answered on matters relating to agricultural pests, diseases and new cultivation techniques. Invited speakers are used to present their views on agricultural technology.

Participation with farmers from other provinces assists in the training and communication by television, and Mekong Delta radio is used to inform farmers of changing technologies.

Participation with other provinces and linkages between districts are used to assist in the publica-

tion of technical books, newsletters and pamphlets which are distributed to farmers.

The extension service covers agro-economy, plant protection, soil and crop sciences.

Most agricultural technicians in the Mekong Delta have graduated from Can-Tho University. In the past 15 years over 2000 agricultural technicians have graduated from this university. Therefore the extension network in this area is strong.

Infrastructure

Transportation

Tra-Noc has an electricity company, military and civil airports, a port capable of accommodating 10 000-t ships, a good road system and also good fluvial systems.

Industrial services

Industrial facilities in the province include the Tra-Noc Thermos-generating Electricity Plant, the Can-Tho Electricity Plant, an engineering plant, an industrial gas enterprise, a tyre-making plant, the Phuoc-Thoi Cement Plant, a concrete enterprise, an integrated pharmaceutical enterprise, an oil and soap producing plant, and the Can-Tho Plastic Enterprise.

The province will be developed as an industrial and processing zone, and plans to develop a manufacturing industry to service agricultural needs have been drawn up.

Agricultural services

Agricultural services include the Tra-Noc silo system, a rice mill, the animal feeds processing plant, the agricultural machinery preparation plant, the fertiliser and chemical plant, the feather processing enterprise, a beverage producing plant, and a frozen vegetable plant.

General status of rural sector

- Can-Tho is the most developed province in the Mekong Delta.
- Climate and soil are favourable for agriculture. An adequate water supply throughout the year enables 2–4 crops per year.
- Can-Tho is currently concentrating on the development of orchard industries.
- Animal feeds are cheap and livestock has high development potential.

CHAPTER 4

Agriculture Production

Agriculture is an important part of Vietnam's economy. Details of crop and livestock production are given in Appendixes 6–13. The relationship of crop to livestock production is listed and the changes that have occurred throughout the last decade are demonstrated.

The major countries which imported Vietnam's agricultural produce in 1990 were USSR, Albania, Bulgaria, Cuba, France, Indonesia, Japan, Hongkong, Singapore, Australia, France, United Kingdom, Italy and Canada (Appendix 38). The value of agricultural exports for the past 10 years is given in Appendix 37.

Details of the more important crops and their significance to Vietnamese agriculture are given in this chapter.

Rice

Production

During 1976–1989 Vietnam imported 0.5–1 Mt of rice per year. A change in policy in 1986 reversed the situation so that by 1990 Vietnam exported 1.5 Mt. Vietnam now ranks third after Thailand and the U.S. as an exporter of rice.

Vietnam's potential for increasing production of rice is considerable, particularly if stable markets can be established, and if more science and technology, even if only at postharvest stage (especially drying and storage), can be applied.

Vietnam can produce up to three crops a year. The yield of rice is approximately 3.3 t/ha and could be increased to 5 or even 6–7 t/ha.

Poor production in the past arose largely through the transfer of farmers to government cooperative farms and the use of heavy equipment. Vietnam's ability to manufacture modern and appropriate equipment is low.

In 1986, state farms were disbanded and farmers returned to smallholdings. In the next 10 years it is anticipated that the trend will be to use small to medium sized equipment and machinery on these smallholdings, probably on a cooperative basis.

The production of rice in 1991 was 19.4 Mt, of which the Mekong River Delta produced 10.3 Mt. Apart from Ben-Tre which is the homeland of coconuts and had the lowest production of rice (363 000 t), all the other provinces in the Mekong Delta each produced about 1 Mt of rice. Appendixes 14 and 15 contain details of rice production and rice growing areas by province.

Table 11 describes rice harvesting and postharvest procedures.

Table 11. Postharvest procedures

Processes	Resultant products
Harvesting	Stalks and kernels
Threshing (kernel collection)	Kernels and stalks
Drying	
Cleaning	
Storage (long term storage)	
Hulling (paddy separation)	Brown rice and hulls
Whitening (bran separation)	White rice and bran
Polishing	
Grading	Whole and broken rice
(separation of broken rice)	
Storage (ready for use)	
Milling	
Marketing	

Postharvest losses of rice in Asia

Losses of rice occur at every stage of production, from planting to consumption (Table 12).

- Preharvest losses due to insects, weeds or diseases affecting the crop.
- Harvest losses due to breaking and shedding of the grain from the ears to the ground.
- Postharvest losses due to inadequate handling, drying, transportation, storage and processing.

Losses also occur due to changes in the availability, edibility, acceptability or quality of rice that reduces or destroys its value.

The major causes of loss or deterioration are:

- microorganisms (fungi, bacteria and yeasts)
- insects and mites
- birds
- rodents
- chemical and microbiological degradation.

Table 12. Estimated postharvest losses of rice, Asia

Harvesting activities	Percentage losses
Cutting	1–3
Transportation	2–7
Threshing and cleaning	2–6
Drying	1–5
Storage	2–6
Milling, processing	2–10
Total	10–37

Source: Le Doan Dien 1992.

As a comparison, statistics from the Japanese Ministry of Agriculture show that postharvest losses of rice in that country are only 3.9–5.6%.

Preharvest factors

The time to harvest rice is critical. Harvesting of immature rice gives rise to an inferior product. If rice is left too long before harvesting, rice grains will fall to the ground resulting in significant losses. Pest such as birds and rodents will increase these losses.

Harvesting

Farmers still harvest manually. There has been some research on harvesters based on the IRRI models. The models are appropriate: however, harvesters have not proved popular, largely because of social factors. Most farmers have only a small plot of land (not enough to use harvesters); running costs for fuel are too high; and most farmers are too poor to afford such machinery.

Threshing

There is a need for mechanical threshers to be checked frequently to ensure that no unnecessary damage to the rice grains occurs. There are many different mechanical threshers available, with different operating modes that are suitable for farmers. In general, most of the provinces have at least one manufacturer of threshing machines. Machines from each province have their own characteristics.

Drying

The moisture content of harvested paddy is usually over 20%. This should be reduced to about 14% for efficient storage, hulling and processing. If paddy is hulled above this moisture content, the performance of machines is usually poor.

At present, there are no dryers that are economically suitable for farmers. Only 10–15% of autumn rice is dried by mechanical drying. The remainder is sun dried on the roadways and this leads to very high losses through wetting by rain, resulting in a large proportion of broken rice.

Excessive heat from the roadway surface is also a cause of broken rice because rapid drying results in the development of hairline cracks in the endosperm of the paddy grain. These cracks enlarge and produce a higher proportion of broken rice during subsequent operations.

With very wet paddy, a two-stage drying process is recommended. Aeration of the paddy between the two drying stages is a good practice.

Drying of agricultural products, particularly rice, is considered one of the highest priorities in Vietnam.

Using the example of Vinh-Long province (see Table 10), almost 220 000 t of rice harvested in the rainy season is, because of consistent wet weather, not properly dried. Rice losses are estimated to be over 20% of total production during August–November.

In Vietnam most rice is dried to 17–18% moisture content (rather than 14–15%) before being sold to companies or brokers.

In recent years, research has led to the development of high-capacity dryers. However, the cost of these dryers is too high for farmers. The drying of agricultural products is only applicable for cooperative farms, brokers or buying organisations and food processing companies.

Cleaning

Cleaning consists of separating the sound kernels from impurities, including chaff, and can be accomplished by sieving and winnowing. If the separation of impurities is not carried out before hulling, the presence of small stones and other hard substances may cause damage to the huller. The

presence of straw may cause an uneven flow of paddy to the huller.

Storage

Improved storage of agricultural products, including rice (over 20 Mt a year), is a high priority in Vietnam. Efficient storage is essential if adequate stocks for exporting and processing are to be established.

Vietnam has four groups of silos:

- at Tra-Noc (Can-Tho), capacity 10 000 t
- at Cao-Lanh (Dong-Thap), capacity 48 000 t
- at Soc-Trang, capacity 12 500 t
- at Tan-Tuc (Binh-Chanh), capacity 12 500 t

The nature of the difficulties experienced with rice storage is demonstrated at a large food company at Song-Hau in Can-Tho province.

At this establishment 16 silos were constructed but only eight were completed with all necessary equipment. The remaining eight silos are being used ineffectively as badly designed warehouses.

Of the eight functional silos, total capacity is 20% below optimum due to water leakage and poor design.

The floors of the silos are flat, requiring extensive manual labour to remove all the grain when emptying. The interiors of the silos are subject to extreme temperature variation due to inadequate insulation and ventilation. Variation in humidity is responsible for yellowing of the rice grains, with subsequent loss of quality. Excess moisture has even caused stored rice grains to sprout. The storage time of rice in these silos is barely 6 months before the onset of irreversible spoilage.

Rice is stored by most farmers for family use. The most common storage container is a crib, which is a large bamboo cylinder erected on a wooden base inside the house. The sides are insulated with mud and closely woven mats are used as lids.

In the Mekong Delta some family farms harvest up to 5 t of rice a year, much of which is lost due to a lack of storage facilities. If all this rice could be sold at optimum prices, the wealth of farming communities would be such that they could invest in updated machinery and further increase yields.

Postharvest pests and diseases

Stored agricultural products such as grains, tuber crops, dried fruits and nuts are subject to infestation and destruction from more than 100 different pest species. The pests that attack stored grain include mainly beetles, a few mite species, birds and rodents.

Aflatoxin formed as result of mould and fungal growth make much stored grain unsafe for human consumption.

The major pests and diseases that affect stored rice are described in Appendix 28.

Hulling

Hulling involves the removal of hulls (or husks, or shells) from the paddy grains to yield brown rice.

Buyers of rice usually purchase grain with a relatively high moisture content. The rice is then dried to a moisture content of 14–15% before grading and hulling. These processes increase the ratio of broken rice to good rice.

Small to medium-scale equipment for grading and treatment of grains before hulling is not available. Different size grains tend to increase the quantity of rice broken in the hulling process.

Whitening and polishing

Whitening refers to the removal of the bran layers, a separate operation to hulling. The bran adheres to the endosperm and has to be removed by rubbing. Polishing is the final operation and consists of smoothing the surface of the white rice so that it has a more acceptable appearance.

In large-scale processing plants, these operations are multistage and use a succession of specialist machinery. Smaller scale operations are less efficient and there is a need to design and develop machinery with a capacity to process 300–400 kg batches.

Grading, quality control and standardisation

Specifications for rice have been accepted in Vietnam but problems relating to these specifications still occur between seller and buyer.

Total losses

There are no reliable estimates as to the total losses of rice in Vietnam but there is sufficient evidence to demonstrate that the losses which occur could be reduced.

Processing of rice

Most rice sold by Vietnam is in an unprocessed form. Returns would be greater if some of this rice were processed into products such as dried pre-cooked rice, rice flour, rice paper and noodles before export. Vietnam lacks the factories to perform these processing functions. Processed rice has many advantages over the raw product, the main one being its shorter cooking time. It is customary in Vietnam to cook rice twice a day and this is very time-consuming.

Use of rice by-products

As shown in Table 11, products and by-products obtained from rice cultivation are kernels and stalks, brown rice and husks, white rice and bran, and whole and broken rice. Proportions of each by-product are shown in Table 13.

Table 13. Rice and its by-products

Product	Proportion (%)	Total amount (Mt)
Paddy	100	19.0
Husk	20	3.8
Bran	10	1.9
Broken rice	10–25	1.9–4.7
Head rice	45–60	8.6–11.4

There is a huge amount of by-products produced in the milling process, much of which is wasted or inefficiently used. The establishment of profitable cottage industries using rice by-products would reduce waste and protect the environment.

Maize

Maize production 1990

Entire country	
Growing area	432 000 ha
Production	671 000 t
Yield	15.5 t/ha
Northern regions	
Growing area	298 000 ha
Production	453 000 t
Growing provinces	Ha-Tuyen, Cao-Bang, Lai-Chau, Hoang-Lien-Son, Vinh-Phu, Ha-Noi and Hai-Hung
Southern regions	
Growing area	134 000 ha
Production	218 000 t
Growing provinces	Dac-Lac, Lam-Dong, Dong-Nai and An-Giang

Further details of maize production and growing areas are given in Appendixes 16 and 17.

Maize is used as food for humans and animals. The foliage is used as cattle feed.

There is a need to develop processing methods so that there is a greater variety of maize products available for human consumption. Ideally, processing facilities should be available in most villages.

The major pests and diseases that affect stored maize are described in Appendix 28.

Root Crops and Vegetables

Overview

There is a long history of cultivation and consumption of root crops and vegetables in Vietnam. They appear in many kinds of Vietnamese dishes. The average consumption of food crops in Vietnam is 376 kg/person/year, of which: 293 kg/person is rice, 40 kg/person is cassava, 30 kg/person is sweet potatoes and 13 kg/person is maize. Tables 14–16 give area and production statistics and targets.

Constraints

Difficulties facing farmers in Vietnam relate mainly to the lack of education and the small size of the farming areas.

The production of root crops in Vietnam has declined between 1980 and 1990 due to:

- poor cultivars, declining species
- lack of experience of monoculture
- lack of suitable fertiliser
- lack of markets and processing facilities
- low price and lack of support policy from the government.

The development of processing techniques for root crops are limited due to:

- fluctuation in prices, unstable markets
- lack of revenue to stockpile enough raw materials
- lack of stable suppliers of raw materials.

Table 14. Production of root crops, 1990

Crop	Amount (Mt)
Root crops	7.10
Cassava	2.28
Sweet potatoes	2.00
Potatoes	0.87
Others	0.50

Source: Statistical Publishing House 1992.

Table 15. Cultivated areas of root crops, 1988

Country	Area (million ha)
China	9.25
Thailand	1.59
Indonesia	1.58
India	1.33
Vietnam	0.80

Source: FAO–RAPA 1989, in Hoang-Kim et al. 1992.

Table 16. Cultivation and production targets for root crops, 2000

	Whole country	North	South
Cultivation (million ha)			
Cassava	0.5	0.22	0.28
Sweet potatoes	0.6	0.33	0.28
Potatoes	0.2	0.20	–
Total	1.3	0.74	0.60
Production (Mt)	12.20	7.00	5.20

Source: MAFI 1985, in Hoang-Kim et al.1992.

Cassava

Cassava production, 1990

Entire country:

Production	2.28 Mt
Growing area	256 800 ha
Yield	9 t/ha

Northern regions:

Production	1.18 Mt
Growing area	140 800 ha
Growing provinces	Ha-Tuyen, Lang-Son, Lai-Chau, Hoang-Lien-Son, Son-La, Vinh-Phu, Ha-Bac, Ha-Son-Binh, Thanh-Hoa and Nghe-Tinh

Southern regions:

Production	1.1 Mt (48%)
Growing area	116 000 ha (45%)
Growing provinces	Quang-Nam, Da-Nang, Quang-Ngai, Binh-Dinh, Khanh-Hoa, Ninh-Thuan, Binh-Thuan, Ba-Ria Vung-Tau, Dong-Nai, Lam-Dong, Gia-Lai, Kon-Tum, Dac-Lac,Tay-Ninh and Song-Be

Yields of cassava should be 15–18 t/ha. More details of cassava production and growing areas are given in Appendixes 18 and 19.

Uses of cassava

Cassava leaves are used, after being cooked, for pig and poultry food. They are also used to feed silkworms.

The trunk is used for fencing, as a cooking material (coal), and as a base for growing mushrooms.

The roots have many uses:

- Human consumption
  - Consumed after cooking. There are numerous methods for preparation.
  - Processing into tapioca, sago, noodles, vermicelli and bread.
  - Fermentation to produce alcohol. Yield of alcohol found in Ha-Noi alcohol factory was 1 litre per 1.3 kg of cassava (2 kg of rice is needed to make 1 litre of rice alcohol). Waste from the fermentation can be used for animal feed.
- Animal feed
  - Sliced and dried for exportation and domestic use.
- Industrial uses
  - Fermentation of cassava starch into maltose for silkworm feeding.
  - Use as raw material for the production of monosodium glutamate.
  - Use as material for the processing of glucose for dripping.
  - To produce glue for the textile industry.

Processing

There are over 1000 cassava processing factories in Vietnam, of which 550–750 are in the south. Most of these establishments have capacities of between 3–10 t of fresh roots per day. There are

factories in Ha-Noi, Ho-Chi-Minh City, and the provinces of Son-La, Vinh-Phu, Ha-Bac, Dong-Nai, Song-Be, Tay-Ninh, Khanh-Hoa, Quang-Nam Da-Nang, Quang-Ngai and Binh-Dinh. Son-La, Dong-Nai and Ho-Chi-Minh City process the most cassava.

Cassava is grown in mountainous areas (Gia-Lai, Dac-lac, Lam-Dong). Semi-processing is carried out in suburban areas of cities such as Quang-Nam, Quang-Ngai, Binh-Dinh, Nha-Trang and Song-Be.

The rainy seasons occur from August–January. There are few sunny days in October and November which makes it difficult to dry sliced cassava or process flour. In North Vietnam, with cool to cold weather, starch can be kept in anaerobic storage conditions for up to 6 months.

Sweet potato

Sweet potato production, 1990

Entire country	
Production	1.9 Mt
Growing area	320 000 ha
Yield	6 t/ha
Northern regions:	
Production	1.4 Mt
Growing area	240 000 ha
Growing provinces	Bac-Thai, Quang-Ninh, Vinh-Phu, Ha-Bac, Ha-Noi, Hai-Hung, Thai-Binh, Ha-Nam-Ninh, Thanh-Hoa, Nghe-Tinh and Thua-Thien Hue
Southern regions:	
Production	0.5 Mt (27%)
Growing area	80 000 ha (25%)
Growing provinces	Quang-Nam Da-Nang, Thuan-Hai, Dac-Lac, Hau-Giang and Kien-Giang

Further details of sweet potato production and growing areas are given in Appendixes 20 and 21.

Sweet potatoes can be sliced and dried for consumption by humans, pigs, cattle and poultry. There is no processing technique suitable for use at village level because although farmers have the knowledge they lack the equipment needed.

There are four processing areas: Da-Nang, Phan-Thiet, Lam-Dong and Ho-Chi-Minh City.

Sweet potato products include beverages, confectionery and potato crackers.

Potato

The main species grown in Vietnam is *Solanum tuberosum*. The growing areas (200000 ha) are mainly in the north of the country.

The major pests and diseases that affect stored potatoes are given in Appendix 28.

Canna

First grown in 1960 as an alternative food to rice, canna is very easy to grow and is not usually affected by floods, storms or insects. After processing, 14–15% of the canna roots are converted to high grade starch. Processed products include vermicelli and noodles.

Canna is grown in most of the provinces of the Southern Central Coast, the Central Highlands and Dong-Nai. Growing area now is about 20000 ha.

Vegetables

Vegetable production in the Asia–Pacific Region has been growing at an annual rate of 3.1%. Production increased from 16.2 Mt in 1978 to 21.4 Mt in 1988. World production grew at an annual rate of 2% for the same period. Major crops include cabbage, onion, maize, potatoes, and tomatoes.

Although there are many types of vegetables which can be grown in Vietnam only those consumed locally are grown. There are no preserving facilities available and this inhibits export trade.

Common vegetables found in Vietnam include:

- Crucifers — cabbage, Chinese cabbage, cauliflower, broccoli, Chinese turnip, turnip, radish.
- Cucurbits— melon squash, choko, cucumbers, bitter melon.
- Beans — French beans, mung bean, soya bean, black bean, white bean, peas.
- Spices — onion, bunching onion, garlic, ginger, shallot, Chinese leek, chives, chilli.
- Aromatic — water convolvulus, water cress, spinach.
- Others — pumpkin, beetroot, carrots, tomatoes, lettuce, egg plant, capsicums, okra, asparagus, sweet corn.
- Herbs.

The major pests and diseases affecting vegetables are given in Appendix 28.

Industrial crops

Vietnam has a high potential for the development of annual industrial crops. These industrial crops can be planted on a rotational basis or intercropped.

Over the past 5 years, the amount of land used for industrial crops decreased by an average of 1.3% annually. Tobacco decreased by 8.8%, sesame by 7.9%, jute by 6.6%, cotton by 6.3%, sugarcane by 1.8%, and peanuts by 0.25%. Exports based on fragmented production, combined with a weak processing industry, discourage farmers from planting industrial crops.

Soybeans

The growing area of soybeans in 1990 was double that of 1980 (Table 17). Further development of this crop can be expected as long as the soybean milk industry continues to develop. Soybeans are also used in processed foods; for example, bean curd, dry bean curd, soybean milk and yoghurt. It is rich in protein and used to prevent malnutrition.

Table 17. Soybean production, growing area and yield, 1976–1991

	1976	1980	1985	1990	1991
Production ('000 t)	20.7	32.1	79.1	86.6	98.7
Growing area ('000 ha)	39.4	48.8	102.0	110.0	115.4
Yield (100 kg/ha)	5.3	6.6	7.8	7.9	8.6

Source: Statistical Publishing House 1992: 117–21.

Peanuts

Peanut production

Production:	(1980)	97 000 t
	(1990)	213 000 t
Growing area:	(1980)	106 000 ha
	(1985)	212 700 ha
	(1990)	201 000 ha
	(1991)	196 000 ha

More details of peanut production and growing areas are given in Appendix 22.

The cultivation of peanuts helps enrich the soil. In Vietnam, peanuts are normally planted in rotation with rice, or intercropped with other vegetables. The area under peanuts is greater than that under soybeans. The production of peanuts in the 1980s increased rapidly but is presently declining.

Some 40% of peanut production is for export, and this is predicted to continue. Although peanut and coconut oil is produced locally, domestic consumers prefer lard to vegetable oil.

The major pests and diseases that affect stored peanuts are described in Appendix 28.

Cashew nut

Cashew nut production

Production of raw cashew nut: 140 000 t/year
Growing areas: 100 000 ha
Expected growing area in 2000 is 150 000 ha
Main growing provinces: Da-Nang, Binh-Dinh, Quang-Ngai, Phu-Yen, Khanh-Hoa, Thuan-Hai, Dong-Nai, Song-Be, Tay-Ninh, Dac-Lac and Ho-Chi-Minh City

In 1988 cashew nuts were imported by USA (38 600 t); U.K. (4200 t); Canada (3300 t); Germany (3380 t); Japan (3700 t); USSR (3200 t); Holland (2900 t); and Australia (2000 t).

Cashew nuts are an important commercial commodity on the world market. Although they have been grown in Vietnam for over 200 years, the development of large-scale production commenced only in 1983 with the establishment of export markets.

Ecologically, cashew is an important plant in South Vietnam because the climatic conditions are suitable and it can grow on previously denuded land. Moreover, it does not require large initial investments, the harvesting time is short, and its economic value is high.

Storage methods for cashew nut are very important. The cashew nut season is very short and the processing factories need to have a sufficient supply for the entire year. Raw cashew nuts are dried and the raw material stacked in piles inside sack containers. Inspectors have to check regularly for the presence of mould and insects (beetles) which can render the cashews useless.

Coconut

Coconut production

Entire country		
Production	(1980):	311 000 t
	(1985):	612 000 t
	(1990):	894 000 t
	(1991):	1 039 000 t
Growing area	(1980):	44 000 ha
	(1985):	80 000 ha
	(1990):	121 000 ha
	(1991):	134 000 ha

Northern regions (1991)	
Production:	26 700 t
Growing area:	2 600 ha

Southern regions (1991)	
Production:	1 012 000 t (97.4%)
Growing area:	132 000 ha (98%)

Production by some major provinces: The Mekong Delta produced 770 000 t, of which Ben-Tre province produced 156 000 t, Vinh-Long and Tra-Vinh 238 000 t, Can-Tho and Soc-Trang 98 500 t, Minh-Hai 75 000 t and Kien-Giang 72 000 t.

Further details of coconut production and growing areas are given in Appendixes 23 and 24.

Constraints

The growing areas and production of coconut in 1991 compared with 1980 are 3 and 3.3 times higher, respectively. However, the future of coconut growing is uncertain.

Coconut trees in the Mekong Delta are 20–25 years old, which is the most productive age. The coconut oil produced was previously exported to the Soviet Union, but this market is now lost. The domestic market for coconut oil is not good because it costs more than palm oil. Palm oil is tax free but coconut oil is subject to internal taxes. Consequently, coconut oil returns are relatively low and, in 1991, many coconut trees were replaced by orange and mandarin trees.

Large quantities of coconut shell and fibre are available, but there is no technique to utilise these materials. Coconut by-products include coconut oil and activated carbon from coconut shell and fibres. The activated carbon produced is of low quality.

Sugarcane

Sugarcane production

Northern regions (1990)	
Production :	700 000 t
Growing area:	20 000 ha

Southern regions (1990)	
Production :	4 700 000 t (87%)
Growing area:	111 000 ha (85%)

Production of some major provinces: Quang-Ngai 340 000 t; Dong-Nai 400 000 t. Mekong Delta produced 2 500 000 t of which Hau-Giang had 700 000 t; Ben-Tre 526 000 t; Long-An 345 000 t; Cuu-Long 206 000 t.

More details of sugarcane production and growing areas are given in Appendix 25.

Sugarcane in Vietnam has been cultivated in infertile soils using only small amounts of fertiliser. Yields are therefore low, only 4 t/ha, representing two-thirds of that produced by other countries.

Peak development of sugarcane in Vietnam occurred from the second half of the 1970s to the early 1980s, but then declined steadily. Sown area and production in 1984 were 162 200 ha and 6.6 Mt. In 1990 the corresponding figures were 131 000 ha and 5.4 Mt, respectively. Development trends for sugarcane in Vietnam have not been clearly identified.

Sugarcane is mainly used for sugar production, with only 10% of output for daily needs. The sugar mills with a total capacity of 11 000 t of sugarcane per day can only process 50% of total cane production. The remainder is extracted manually. Most sugarcane growing regions are remote from the sugar mills.

The major pests and diseases affecting sugarcane are described in Appendix 28.

Mulberry

This crop has good prospects as an export earner. Mulberry cultivation, silkworm breeding, silk spinning and weaving are Vietnamese activities. The world demand for natural silk has increased. A corporation to build modern silk spinning factories, Mulberry and Natural Silk, has been set up as a joint venture with South Korea and Italy.

In 1991, Lam-Dong province had 6000 ha of mulberry, representing 50% of the growing area of the entire country. In 1990, Vietnam's silk output

was 450 t. By 1995 this figure is predicted to be 2000 t.

Farmers can derive more benefits from silkworms than any crops, but the silkworm can only be reared effectively in cool climates.

Beverages

Tea

Tea production

Production	(1980):	94 500 t
	(1985):	127 000 t
	(1991):	154 000 t
Growing area	(1980):	46 900 ha
	(1985):	50 800 ha
	(1991):	61 200 ha

Vietnam has good tea cultivars. This is a traditional export crop which has expanded continuously since 1976.

The major pests and diseases affecting tea are described in Appendix 28.

Coffee

In recent years the area under coffee cultivation has rapidly expanded. In 1990, the growing area was 119 300 ha, 6.3 times higher than in 1976.

The output of fresh coffee beans in 1990 was 320 500 t and in 1991 was 353 300 t. Because of world overproduction Vietnam's output has been sold mainly to the former Soviet Union and Eastern European countries. These markets are now under threat.

Instead of growing the more popular Arabica coffee, Vietnam has mainly cultivated Robusta coffee which gives a high yield but is of lower quality.

The major pests and diseases that effect stored coffee are described in Appendix 28.

Fruit Crops

The situation for fruit is similar to that for other commodities. Farmers have good land, fertile soil, favourable climate, and an excess of labour that is willing to work hard. Income from orchards is very high compared with rice, but development of orchards is hindered by the lack of credit, management and markets. As it takes approximately three years before orchards can provide any income, farmers have to grow fruit trees together with other crops in order to have some income while waiting for returns from their orchards.

Orchard establishment is strongly encouraged by most provincial departments of agriculture. However, prices sometimes fall to low levels, and quotas or underwritten minimum floor prices may be required.

Further development of orchards will depend on suitable progress being made in fruit handling, treatment, storage, packaging and transportation, and fruit preservation and processing.

Fruit crops and fruit-growing seasons in Vietnam are given in Table 18.

Oranges

Oranges are grown over large areas in Vietnam, in both the north and south. There is even greater potential if export markets can be established.

Details of orange production and growing areas are given in Appendixes 26 and 27.

The major pests and diseases that affect oranges are described in Appendix 28.

Medicinal Materials

The use of natural resources for medical treatment and health care is traditional in Vietnam. The country has a long sea coast, long rivers and a multitude of forested mountains with an abundance of diverse plant species. Many of these species can be used as medicine. Indigenous drugs are readily available from the sea, forests and in the immediate vicinity of villages.

Some 1863 plant species from 238 families have been identified.

The successful combination of modern and traditional medicine has given impetus to the gradual modernisation of herbal medicine to facilitate handling and promote exports. Some medicines are exported as finished or semi-finished products. Essential oil production has grown in recent years. Some modern equipment has been introduced for the industrial production of indigenous medicines and herbal medicaments. These medicines can now be used as substitutes for synthetically produced drugs, and Chinese herbs which were formerly imported.

Certain medicinal plants need to be processed before use so as to make the drug suitable for human use; eliminate unwanted properties or adverse side-effects; and improve the smell and taste of the drugs for ease of administration.

Table 18. Fruit and fruit seasons of Vietnam

Fruit	Months grown											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avocado												
Banana												
Dragon												
Durian												
Grapes												
Guava												
Jack fruit												
Lemon												
Lime												
Longan												
Lychee												
Mandarine												
Mango												
Mangosteen												
Milk fruit												
Orange												
Papaya												
Pineapple												
Pomelo												
Rambutan												
Sapodilla												
Sour–sop												
Sweet–sop												
Watermelon												

Source: Vegetexco brochure.

The storage of medicinal plants

Medicinal plants must be carefully stored to preserve their properties. There are five major factors that affect the quality of medicinal herbs.

- Moisture. Excessive moisture may cause fungi, moulds and pests to develop in the herbs.
- Temperature. Storage temperature should be less than 25°C to avoid evaporation of essential oils and decomposition of lipid components in herbs.
- Length of storage. Prolonged storage may lead to deterioration of active components in herbs.
- Packaging. Traditionally, herbs are packed in fibre sacks, reed bags or wooden boxes.
- Fungi, mould and insect pests. Regular checking to detect mould development is important so as to enable prompt isolation and treatment of the infected herb.

Livestock

As indicated in Appendixes 29–30, the livestock industry in Vietnam has increased steadily over the last decade. Liveweight production increased from 456 000 t to over a million tonnes.

Pork and poultry are the most popular meats in Vietnam. From 1980–90 the production of pork increased from 292 000 to 800 000 t and the production of poultry from 99 000 to 260 000 t. Pig and poultry breeding is a traditional household practice in Vietnam.

Increased food processing should further expand the meat industry because of increased export opportunities.

Research institutions have been successful in breeding suitable species of pig, poultry and ducks. A goat breeding program has also been introduced. The breeding of buffaloes and cattle is in decline due to the proliferation of small farms that are unable to develop herds of reasonable size. There is a reluctance by many farmers to kill their buffaloes and cattle because they treat them as pets.

The dairy industry should be developed because currently Vietnam imports US$20 million worth of milk powder a year. North Montane and Midland or Central Highlands would be ideal locations for the development of a dairy industry.

More detailed information is given in Appendix 31.

Fisheries

Resources

Marine resources

Currently over 1 Mt of fish are caught annually. Some 2000 species have been identified, of which 100 have significant economic value.

Large reefs are found in the following provinces: Quang-Ninh, Hai-Phong, Quang-Binh, Quang-Tri, Thua-Thien Hue, Phu-Yen, Khanh-Hoa, Binh-Dinh, Ninh-Thuan and Binh-Thuan. The reefs harbour the greatest concentration of many species, especially those of high economic value, such as lobsters (Palinuridae), red snapper (*Lutianus*), grouper (Serranidae), grunt (Pomadasyidae), cuttlefish (*Sepia*), tuna (Thunnidae), and flying fish (Exocoetidae).

The fishing grounds may be divided into four main areas: Bac-Bo Gulf, Central Sea, Eastern and Western seas in the south of Vietnam.

Bac-Bo Gulf contains mainly coastal fish species. There are 960 species, of which 60 have commercial value.

There are 80 families of fishes in the Central Sea, comprising 175 species. The species which give high yields are grey grouper (*Malakichthys griseus*) (29%) and hairtail (Trichiuridae) (22%).

The Eastern Sea of the south contains 105 families, comprising 369 species. The species which give high yields are lizardfish (Synodidae) (35%) and jacks (Carangidae) (30%).

The Western Sea of the south contains 70 families, comprising 270 species. The species which give high yields are flower-fish (Liognathidae) (32%) and jacks (Carangidae) (18%).

In addition to fish, there are 1650 crustacean species of which shrimp and prawn are the most economically important. There are also 2300 species of molluscs, of which many species are of market value: squid (*Loligo*), cuttlefish (*Sepia*), scallop (*Chlamys*), oyster (*Ostrea*), abalone (*Haliotis*), cockle (*Arca*), pearl oyster (*Pteria*) and mussel (*Mytilus*).

There are over 600 species of seaweed, of which *Gracilaria asiatica* is the best known.

Inland fishery resources

In the north there are 240 species, most of them herbivorous. In the south there are 255 species mostly carnivorous. There are also many species of freshwater crustaceans such as giant prawn (*Machrobrachium rosenbergii*), molluscs such as snail, clam, mussel and many species of reptiles such as turtle and crocodile.

Tidal, lagoon, strait and bay resources

In the Red River estuary and the northern plains there are 150 species of fish and shrimp; in Quang-Ninh, Hai-Phong area there are 180 species of fish and shrimp; in the central lagoons there are 140 species of fish and shrimp; and in the Mekong River estuaries there are 155 species of fish and shrimp.

Development

Marine fishing

In 1992 Vietnam had over 40 000 motor fishing vessels, with a total labour force of 300 000 people engaged in marine fishing.

Over 50 000 t of prawns and more than 30 000 t of cuttlefish are caught annually. Other products which contribute to the total marine industry include crabs, oysters, abalone, jellyfish, pearl, coral and marine plants.

Details of fish production and exports are given in Appendixes 32 and 33.

Aquaculture

Throughout the country, approximately 530 000 ha of land are devoted to aquaculture, which includes fresh, brackish and saltwater cultivation. There are 375 fish hatcheries and 115 prawn hatcheries with a production of over 500000 t. Cage and pen culture are also well developed. The labour force engaged in aquaculture is estimated to be 260 000 people.

Details of potential areas for aquaculture are given in Appendix 34.

Transportation, storage and processing facilities

There are 300 boats to harvest fish and other seafood. These boats are owned by 30–40 merchandise companies which purchase most fish catches. It may take 4–10 hours before the fish catches reach the processing factories. During this time the fish are usually stored in boxes containing ice. The ice often causes physical damage to the fish due to its weight, sharp edges and inappropriate handling.

In addition:

- There are ice-making factories with a total capacity of 2000 t/day.
- There are 126 freezing/cooling plants with capacities of 500 t/day.
- Vietnam owns 28 refrigerated ships having a total capacity of 6150 t. These ships are mainly used for the transportation of fish and fish product exports.
- Road transportation is provided by a 115 refrigerated lorries with a total capacity of 800 t.
- A total of 180 ML of fish sauces is produced annually in Vietnam's 100 fish-sauce plants.

Fish exports

The major importing countries of Vietnamese fish and seafood are Japan, Hong Kong and Taiwan. Australia and France import lesser quantities. Hong Kong imports live prawns, crabs and sleeping lobsters.

The production of prawns is insufficient for Vietnam's processing facilities to be used at full capacity.

Vietnam has a high catching and exporting potential, but fishers are equipped with only small boats, lacking storage facilities. The fishing infrastructure is haphazard and scattered and lacks centralised management, resulting in variable quality and very high harvest losses. One of the reasons for these losses is the fact that processing factories are often distant from the fishing grounds and there is often inadequate cooling facilities during transportation.

The extent of losses at harvest varies, depending on the fishing techniques and the type of equipment used. It is estimated that about 30–40% of fish caught is lost due to inadequate postharvest control. There are no accurate figures available because there has been no research conducted into this problem.

Most fish and seafood are sold to merchants and exporters very cheaply. A large proportion of prawns is sold after the removal of heads and shells. Only very fresh prawns can be exported in their original condition. Whole prawns are more valuable. Vietnam fails to obtain maximum value for its prawn catches because of inadequate storage.

For domestic consumption, a high percentage of fish is used to make dry fish and fish sauce because of their better keeping qualities. These products do not earn the fishers as much income as fresh fish. An initial investment to develop satisfactory storage facilities would, in the long term, improve the income of many fishers. The economic status of most fishers in Vietnam is very poor.

There would appear to be an opportunity for entrepreneurs to invest in independent quick frozen techniques and improved storage facilities for fish in Vietnam.

Hai-Phong Seafood Company buys about 15 t of fish and seafood products per day.

Food processing

Food processing should be the highest priority for further agro-development and also for meeting the new demands of the tourism industry. As part of the strategy, Vietnam has targeted food processing as one of the top priorities for foreign investment.

There are some 8000 food-processing plants, which provide work for some 650 000 workers.

At present rice milling represents the most important agricultural processing activity in the country, it includes some 3000 plants and employs 100 000 workers. Rice mills belong both to state and joint venture enterprises. Other major food-processing plants have been built for seafood, meat processing, sugar processing, flour, flour products and animal feed. There is minor production of alcohol, spirits, beer and other beverages.

Detailed information on processing industries is given in Appendixes 35 and 36.

Constraints

- The lack of an efficient infrastructure, particularly regarding electricity supply and transportation.
- The lack of initial capital.
- The lack of markets.
- Insufficient technology and facilities for food packaging.
- Inadequate marketing strategies.
- Inadequate food technology experience.

CHAPTER 5

Major Issues Relevant to Vietnam's Rural Sector

Cultural Factors

Introduction of modernised farming methods

In Vietnam, particularly in rural areas, the family unit is very important. Life within the community is based on willing cooperation, and the people resist mandatory regulation, as demonstrated by the unsuccessful farming policies during the past few years.

To achieve the maximum output from Vietnamese farming communities it is essential to involve individual farmers as much as possible in the decision-making processes. Care must be taken to explain the benefits that can be obtained by introducing innovations such as mechanisation into the farming community. This process should take into account the individual importance of every family involved in primary production.

Change must not be seen as being too rapid, or as threatening the livelihood of individuals. The introduction of modernised farming methods must be carefully planned and be appropriate to the land areas and traditional farming methods in each region.

A significant factor in the introduction of mechanisation is the initial purchase price. To be viable, the cost of the machinery should be recovered by increased productivity within a few years.

Unlike most western countries, the cost of labour is relatively cheap, and the introduction of new farming procedures is likely to be more successful when increased productivity can be demonstrated, as distinct from a reduction in labour input. Machinery capable of increasing yields or eliminating wastage would be more acceptable than labour-saving products.

Along with the introduction of improved farming methods and mechanisation, there will be a need to train farmers in their utilisation and, perhaps more importantly, to demonstrate the benefits to be gained by improved agricultural methods.

Cottage industries

In conjunction with improved farming methods, consideration should be given to expanding the range of agricultural products produced by each community. Further benefits could be obtained by training farmers in postharvest processing, and cottage industries could be established.

Role of women in family and society

The role of women in these changing rural societies should not be neglected or underestimated. There is a need to understand the role of women in Vietnam: how society recognises their value; how they contribute to family and social values; and their role in education and the environment.

Gender issues need to be considered before innovations are introduced into farming communities.

Social Changes

Vietnam has recently undergone important economic changes due to the after-effects of the war. Socialist ideology is being replaced by the introduction of the free market economy and enterprise system. These changes are occurring at a rapid rate and are having dramatic social effects.

Changing to a market economy

There is pressure to establish new export markets and to expand the range of goods produced in Vietnam. These changes challenge traditional concepts of Vietnamese life. Times of social change generate new opportunities but also

produce problems. Vietnam will have to overcome difficulties, establish a firmer financial base, and adjust to a changing social environment. Gone are the days when the population depended entirely on government for leadership, creation of jobs and social structures. Large government corporations are being replaced with much smaller privately-owned businesses.

Agriculture is not excluded from these changing social patterns and must adjust to privately-owned smaller properties. The type and use of farm machinery will have to change to fit into this new social environment. The curricula of agricultural teaching institutes will also have to be updated if the institutes are to attract students interested in careers in agriculture.

Major Needs of the Rural Economy

New markets

The change of government in former communist and socialist countries has led to the loss of many Vietnamese agricultural markets. Vietnam urgently needs new markets to fill this vacuum. New markets are also needed to provide outlets for the recent increase in Vietnam's agricultural production.

Market forecasting

Vietnamese farmers are given very little direction by the government as to what they should produce. This lack of centralised advice has resulted in overproduction of some products and underproduction of others. An inefficient marketing system has resulted in unfilled export contracts in some commodities even where large quantities of the particular product may be widely dispersed throughout the country but have been allowed to rot due to lack of outlets. The problems brought on by inefficient marketing are further exacerbated when many farmers then commence to produce new products. Many examples of the destruction of viable orchards and other long-term crops such as coconuts, pepper and bananas for short-term gains from alternatives can be found throughout Vietnam.

Storage management

Due to a lack of management skills and storage facilities, Vietnam has difficulty in developing export markets even when surpluses of some commodities have been produced by farmers.

Farmers are forced to sell their produce for low prices because they are unable to store it adequately. Insufficient storage facilities also result in large losses due to wastage. The quality of food consumed by the Vietnamese population is sometimes substandard due to deterioration of primary products through mould, insects and mites. The potential of agricultural production in Vietnam is virtually unknown due to the lack of adequate records, poor management and storage. The establishment of a centralised agricultural database for all Vietnamese farmers would be of great value to marketers. Increased communication among agricultural scientists and the creation of efficient extension services would also be of great benefit to Vietnamese rural communities.

Quality management

Market demands for quality products and associated management skills in these new markets will be different from those required for traditional markets established with socialist countries.

Support from government departments

Government departments should be involved in developing marketing policies so as to ensure an orderly program for the buying and selling of produce. It is important that cooperation between farmers be established to maximise agricultural output. Disorderly marketing leads to decreased productivity and high levels of wastage.

Employee and employer relationships

The relationship between employer and employee varies considerably from country to country. A change in working concepts is not easy to achieve without infringing on cultural aspects of society. Management must be aware of tradition when considering radical changes to employment conditions, if a smooth transition is to be obtained. Vietnamese workers perform much better when they are involved in decision making as distinct from being told what to do in an authoritarian manner. The application of a bottom-up policy of management is preferable to a top-down one.

CHAPTER 6

Activities Designed to Improve Productivity

Postharvest Technology

An important area where significant gains could be achieved is in the development of equipment and procedures to minimise postharvest losses. Currently these losses account for a relatively large loss of income to both individual farmers and to the community in general. The introduction of farming aids to assist in deciding the most appropriate harvesting time, is recommended. In addition, there is a need for improved drying and storage conditions to maintain product quality.

Methods of drying grain

The quality of Vietnamese agricultural produce is often adversely affected by natural conditions such as rain, humidity, excessive heat, mould, and rodent and insect damage. Inefficient methods of drying grain are widely used in Vietnamese rural societies. Losses at this stage of production are extremely high and have a major impact on both the volume and quality of the final product and hence on the national economy.

Vietnamese farmers have traditionally worked their individual block of land in a community environment. This tradition should make the sharing of improved machinery and storage facilities relatively easy, providing that such changes are introduced in a sensitive manner.

Diversification of horticultural products

The climate and soil in many parts of Vietnam, especially the Mekong Delta and the eastern region, is very suitable for growing fruit. Commercial orchards have not prospered, however, because of inadequate storage, packaging and transportation of the harvested products. Sales to the local community are minimal because most households have fruit trees.

Commercial orchards could be successful in these areas if the technology were available to prolong the life of the harvested fruit. This could be achieved by establishing modern storage facilities with state-of-the-art technology, improved packaging, and a more efficient transport system.

The expected returns from orchards and associated farming systems would be considerably greater than those obtained from the cultivation of rice. Orchards allow for greater diversity, and can be part of an overall strategy to optimise use of available land. A cyclical program involving orchards, aquaculture and animal husbandry could be developed. Private enterprise should be encouraged to develop these types of activities.

Food processing

To minimise the present large wastage of food in Vietnam, it is considered essential to use technology to prolong the life of produce. This could be achieved by constructing food-preservation facilities. These facilities could be in the form of community factories, or individual farmers could be trained to treat produce on the farm to prolong shelf life.

The extraction of starch from cassava could be carried out on individual farms without major capital input. A significant portion of cassava which is grown in the highlands is currently wasted due to this product having a shelf life of about one day before it changes its characteristics. An inexpensive facility would enable farmers to extract the relatively valuable starch from the plant before it undergoes irreversible changes.

The use of spray dryers in the production of herbs, spices, yeasts and medicinal extract is another inexpensive method to minimise wastage through food processing.

Larger food-processing plants could be used, for example, to convert coconut oil into more convenient forms by employing techniques such as fractionation and hydrogenation.

Small dairy factories capable of converting liquid milk into milk powder, butter, cheese and yoghurt would be another way to add value and minimise wastage. Improvements in the handling of fresh fish and seafood could be brought about without large expenditures of money.

Food legislation

The measurement or estimation of quality requires laboratory inputs and the development of legislation to assist in the rejection of substandard food.

A benefit–cost evaluation is considered necessary before large sums of money are spent to overcome the above-mentioned problems.

The introduction of food legislation for the Vietnamese food industry is considered essential. Australia has well developed legislation and standards which could, with minimal change, be used by Vietnam. Uniform food standards between Australia and Vietnam would be of great benefit in developing trade links. Australian inputs into Vietnamese legislation would also assist in mutual understanding and trade.

Food inspection and an extension service capable of advising farmers how to alter their farming practices when food quality is below established standards are urgently required.

The development of legislation to improve or at least maintain the quality of the environment may also be highly desirable. This legislation could be based on that already in existence in many other countries.

Improvements in quality of produce

Increased returns from agriculture could also be obtained by placing a greater emphasis on the quality of primary produce. In order to improve quality to the standards demanded by many importing countries, Vietnam would need to develop the following.

Appropriate analytical facilities. A modernised food analytical laboratory where produce could be tested for compliance with established standards is needed. This could be achieved by combining the resources of existing laboratories.

Standardisation of product qualities. An analytical testing program comparable to the 'Market basket' surveys in Australia should be commenced as soon as possible. Evaluation of results obtained from such a program would be valuable in locating possible problem areas. Appropriate actions to overcome any problems could then be initiated.

There may be a need for Vietnam to seek assistance from countries such as Australia in gaining the necessary expertise and experience in advanced analytical techniques for determining trace amounts of residues and contaminants in food. Monitoring of the environment for contamination of land, water and the atmosphere may also be essential to produce clean agricultural commodities.

Methods are required to identify aflatoxins and their sources, particularly from peanuts, soybean, maize and dried mushrooms.

Reduction of pesticides. The use of pesticides, fungicides and herbicides may lead to unacceptably high levels of undesirable residues. Without adequate control of these potentially hazardous chemicals, export markets for Vietnamese products could be reduced or lost.

If Vietnam could demonstrate to the world that it produces 'clean' agricultural products its chances of developing new markets would be greatly enhanced. Conversely, irreparable damage could be done if Vietnam had a reputation for producing contaminated food. 'Clean' produce may also command relatively higher prices.

The development and use of alternative approaches to pest and disease management, such as biological controls to replace pesticides, fungicides and herbicides, is considered desirable in order to improve quality. Research into alternative controls should be commenced as a matter of urgency. If the land becomes badly affected with non-biodegradable residues or contaminants it is extremely difficult if not impossible to produce 'clean' food.

Use of biotechnology to help improve genetic potential of crops and livestock to resist pests and diseases. More suitable varieties of plants and grazing stock that would be resistant to, or tolerant of, pests and diseases during growing, harvesting and storage must be introduced.

To be competitive in a rapidly changing world, it would be desirable to establish Vietnamese centres to undertake research on the improvement of crops and animal strains through the use of biotechnology.

Better storage. Adequate storage facilities are required, especially for rice and fruit and other horticultural produce.

Better packaging and transportation. Packaging and processing facilities to improve presentation, transportation and to add value to primary products by processing are needed.

Technology Transfer

Extension services

Because of poor communications, relatively large distances, inefficient transport systems and a

lack of an in-depth knowledge of problems and concerns, agricultural advisory authorities are not always in close contact with rural areas. The development of infrastructure between government and rural communities would be of considerable benefit to the Vietnamese people. It is essential that agricultural extension services be provided.

Cooperation and distribution of information between scientific institutions and local farmers should be improved, and the greater use of extension services for farmers should be encouraged. Extension networks are crucial for such activities.

The introduction of extensive television networks between cities and country areas would be a great aid to communication and could solve many existing difficulties.

Assistance to farmers

Direct financial assistance to farmers is not recommended because the aid would have to be distributed to numerous recipients and the benefit to individual farmers would be minimal.

Rather, it is recommended that grants be made available to many small regions. Each region would then be responsible for the distribution to individual projects. The preferred distribution would be to introduce new varieties of plants and stock that would give improved yields under Vietnamese conditions. This introduction of improved species and varieties would have to be implemented by developing systems whereby farmers would in effect borrow these items for a specified period of time. Consideration would have to be given to the planning of such a scheme so that all regions would eventually receive some benefit.

A simplistic approach would be to make available a number of cattle to every region where cattle farming is viable. Farmers selected to initially receive this benefit would receive on loan a number of cattle, the produce of which would have to be donated to the central region after a set period. These young cattle could then be given to other farmers on a similar lending arrangement. This method of distributing aid was recommended by senior people in Vietnamese scientific institutes, and would not have any adverse effects on the social structure of the Vietnamese communities. An obvious disadvantage would be the lengthy period of time that would elapse before a large number of people would derive direct benefit. The introduction of such a scheme would require considerable planning and management but could be tailored to the amount of aid available.

International cooperation

Coordination between scientific institutes and local farming communities may have to be initiated by personnel from outside Vietnam. Considerable knowledge and effort would be needed to transfer the necessary information to Vietnamese farmers.

Scale of Implementation

The creation of a pilot scheme to act as a model system should be the first step in designing an improved communication network.

CHAPTER 7

Suggested Projects to Assist Vietnamese Agriculture

Agribusiness

Organisation

A private farmers' bank could be established to assist those farmers in financial need and to encourage savings for further expansion. In this regard it is noted that Vietnam has already had discussions with Bangladesh on the Grameen Bank system.

The possibility of obtaining concessional loans from outside agencies such as the World Bank and Asian Development Bank, Bank for Agricultural Development (BAD), Bank for Commerce and Industry (BCI), Bank for Investment and Construction (BIC), and Bank for Foreign Trade (BFT) should be explored.

Marketing boards which guarantee a reasonable return on farmers' produce should be established, as should international cooperation links for interchange of information, ideas and plant varieties.

Farm machinery, even if subsidised, should be made available to most farmers. Preferably this machinery should service the needs of family unit farms. However, without appropriate back-up services for maintenance, this initiative would fail. An agency to distribute and advise on the use of all farm machinery should be established.

Agricultural products, especially in those areas which only produce rice, must be diversified. Returns from fruit products would be considerable if export markets could be established.

The development of cottage industries in farming areas would extend the life of farm produce and add value to primary products.

Better links between the private sector, public sectors, government and research institutions would optimise the use of skills and resources. These linkages should work in cooperation with each other to achieve maximum benefits. The public sector and research institutions should encourage research and extension services. The private sector could undertake marketing.

Before implementing any of the above suggestions, it is recommended that adequate research be initiated to establish a planning strategy so as to have an overall picture of all the needs and supplies. This plan should preferably be commenced with a pilot model to minimise wastage and to maximise benefits.

Finding new markets

There is a need to establish a trade and price information system because there is excessive production of the following products:

- Fruit — avocado, banana, durian, dragon fruit, guava, lychees, longan, mandarin, mango, mangosteen, orange, pomelo, papaya, persimmon, pineapple, rambutan, sapodilla, soursop, strawberry, sweetsop (custard apple), watermelon.
- Coconut and coconut oil.
- Cassava and cassava products.
- Vegetables, especially potatoes and tomatoes.
- Meat (pork, duck, poultry).
- Seafood (fish and prawns).
- Seaweed products (agar).

There is a need for Vietnam to establish export markets for all of the above products. Revenue obtained could be used to improve the efficiency of agricultural production. If markets were established, resources would have to be used to improve storage conditions for most of these products. It may be necessary for Vietnam to consider the establishment of joint venture projects with overseas countries to process food prior to export.

Investment loans

Investment loans are needed in the following areas:

- Machinery and facilities for rice drying, storage, processing, and processing rice by-products (e.g. rice bran).
- Processing cassava.
- Orchard establishment.
- Pest control (preferably integrated pest management).

- Aquaculture (e.g. breeding prawns).
- Development of small scale fisheries.
- Seafood, individual quick-frozen systems.
- Establishment of plants to produce pure agar.

Scientific Projects

The following factors related to harvesting and postharvest activities are important in terms of production and potential crop losses:

- Species variety
- Seed, plant population
- Disease, pest and weed control
- Plant growth regulators
- Previous cropping history
- Harvesting techniques
- Postharvest handling
- Storage
- Husbandry
- Processing

There are numerous scientific projects that could be instigated to enable Vietnam to reach its maximum potential as an agricultural country. Examples of the type of projects that would be advantageous are outlined below.

Horticultural program

A research program could investigate the relationship between orchards, aquaculture and animal breeding and design a program where these three farming activities could be employed in a cyclical and environmentally sound manner.

Horticultural cultivars and quality

- Establish an advisory centre to provide advice and scientific information on the technology of harvesting, postharvest handling, treatment, transportation etc.
- Establish relevant legislation, particularly in regard to application of chemicals.
- Establish standards for quality control. These standards need to be regularly reviewed and updated to harmonise with international standards, especially in regard to chemical residues.
- Develop suitable technology for grading.
- Review of, and research on, existing local species, evaluation of potential species with high quality, high yields and pest resistance so that they are suitable for export.
- Encourage monoculture orchards for small holdings, providing pest and disease problems can be controlled. The benefit of this is to provide uniform produce in sufficient quantities for export and to standardise orchards with similar trees so that maturity assessments and harvest handling techniques can be uniform.
- Encourage diversity across the provinces.
- Replace old trees when necessary.
- Research on the effects of hormones and plant growth regulators to develop fruit with better characteristics without leaving chemical residues.
- Develop biotechnology so that uniform and consistently high quality products can be produced.
- Research to develop new hybrid varieties so as to produce early season products that are resistant to pests and give high yields.
- Acid sulfate soils may be improved by growing pineapples and the extent of this improvement should be investigated.
- Research on the development of suitable orchards that can be satisfactorily grown on reclaimed land.

Control of pests and diseases

This is particularly important during transportation and storage of harvested produce.

- Encourage the development of integrated pest control systems which do not result in unacceptable postharvest chemical residues.
- Establish an effective quarantine system to eliminate new pests and diseases, especially when seed is imported from overseas.
- Orchard sanitation.
- Disinfection procedures for fungi and weevils in citrus fruits.

Handling, treatment, storage, packaging and transportation

The purpose of postharvest treatment is to maximise the useful life of the agricultural product. Appropriate treatments can reduce the rate of deterioration whether by natural ripening, fungal or bacterial attack.

- Ensure a reliable power supply prior to constructing cool storage facilities.
- Ensure a suitable infrastructure and location prior to the development of industrial facilities.
- Ensure packaging technology and materials are available.
- Obtain suitable technical guidelines for postharvest handling and treatment for horticultural products.

- Establish training institutes and extension services for postharvest handling and marketing of horticultural products.
- Establish on-farm handling and treatment procedures.
- Research to evaluate the appropriateness of the various postharvest treatments.
- Postharvest biology, physiology, and pathology of different fruits.
- Control of the atmosphere in warehouses and transport systems.
- Research on the relationship between maturity and shelf life of fruit varieties.
- Establish maturity indices for horticultural produce.
- Research on the perishable nature of various types of fruit and vegetables.
- Reducing losses of perishable fruits i.e. longan, lychee, rambutan, avocado, banana, mango, pawpaw, sapodilla, soursop, sweetsop.
- Permeable coating materials, their effectiveness and possible undesirable side-effects.
- Effect of temperature, concentration and exposure time of acetylene in the ripening of fruit.
- Effect of ethylene and calcium chloride in postharvest technology.
- Preservation of fruit using diphenyl amine, sulfur dioxide, carbon dioxide flushing or ultra low oxygen atmospheres.
- Polyethylene bags to reduce chilling injuries to food.
- Design of low-cost packaging to prevent fruit bruising, and to minimise temperature effects during transportation.

Processing and preservation of fresh horticultural produce

To extend the shelf live of many horticulture products, it is often desirable to subject them to some form of processing.

- Drying of fruits such as banana, persimmon, plum and pineapple.
- Drying of longans to increase their use as traditional medical ingredients or beverages.
- Freezing of durian, jack fruit and boiled soybeans.
- Freeze drying or spray drying to produce a fruit powder suitable for preparing drinks.
- Freeze drying, spray drying or sun drying of yeast, herbs, lemon grass, chilli, ginger, garlic, and some tuber crops.
- Canning or packaging of fruit and fruit juice i.e. pomelo, orange, mandarin, guava, red guava, lychees, longan, rambutan, mangos, mangosteen, pineapple, soursop and coconut milk.
- Canning of mixed herbs and sugar cane syrup to produce a drink.
- Vacuum packing of green bananas and cooked vegetables.
- Production of alcoholic drinks from grape, red rice, coffee, strawberry, and banana.
- Extraction of certain plants such as oranges to produce natural food colours, food flavours, essential oils and medical products.
- Extraction of fermenting and medical enzymes from pineapples.
- Preparation of vegetable products i.e pickles, sauce, canning of beetroot, cucumbers, carrots, chilli, onion, garlic and ginger.
- Preservation of fruit with sugar.
- Preservation of vegetables with salt.
- Manufacturing of jam from fruit i.e. coconut, pineapple, strawberry, soursop, plum.

Use of fruit processing by-products

Some 'waste products' from the processing of agricultural products can be used to manufacture useful by-products:

- Animal substitute feed.
- Vitamin C, tannin, syrup and beverages from cashew apples.
- Cashew nut oil from cashew nut shells.
- Extraction of oil components to use as food additive from mandarin skin.

Rice

Near harvest

There is a great need for research at the near harvest stage. Instruments are available that can detect the best harvesting times for different grains. It would be beneficial to introduce such methods in Vietnam.

Harvesting

- Research is required to improve the traditional method of cutting rice with a sickle. Faster harvesting would enable rice to be collected at the optimum time.
- The need for efficient harvesting and threshing of cereals is important otherwise other preventive measures to minimise food losses may prove of little value, e.g. the husks of grains should not be broken in harvesting because infestation and insect attack will develop more

quickly. The availability of proper equipment for harvesting and threshing, and training in its correct use, is essential.

Threshing

- A study could be undertaken to assess the extent of losses that occur when rice plants are subjected to the widely used method of threshing with small motorised devices. A small percentage increase in the amount of rice obtained from each harvest would add considerably to any profit made by farmers. Broken and damaged rice grains are a significant part of most harvests. The current threshing devices may be a factor in this loss of quality.

Transportation

- Transportation of rice throughout Vietnam could be streamlined so as to decrease the present losses of rice after harvesting. A coordinated approach using large containers should be considered for implementation. This should be a priority project and could be organised by local regions under government direction.

Drying

It is generally considered that relative humidities of 70% are ideal for stored products. Moisture content equilibrium at 70% relative humidity for different products are shown in Table 19.

Table 19. Moisture content equilibrium of various grains at 70% relative humidity (per cent)

Commodity	Moisture content (%)
Paddy	14.0
Maize	13.5
Peanut	7.0
Cowpea	13.5
Beans	15.0
Sorghum	16.0
Millet	16.0
Wheat	13.5
Cotton seed	10.0
Cocoa beans	7.0

Climatic conditions in Vietnam are such that unless rice is dried almost immediately after harvesting, spoilage will occur due to high moisture content. The present method of drying rice on streets and roads causes severe loss of quality due to splitting and cracking of rice grains. This is partly caused by the relatively high temperature of the road surface which almost roasts the rice in contact with the roads.

Installation of special drying facilities would have a positive impact on the quality of Vietnamese rice.

The design of the most suitable type of drying facility may need to be a topic for future research. Solar energy could be used to heat the dryers.

A direct connection between drying facilities and storage bins or silos would be most desirable.

Storage

There is a need to improve the number, capacity and quality of rice storage facilities throughout Vietnam.

It is estimated that Vietnam has the capacity to produce in excess of 1.4–1.5 Mt of rice above domestic consumption of almost 20 Mt. If export markets are obtained there would be a need to develop storage facilities to cope with this excess production.

- Research to maximise the performance of the existing silo facilities would be desirable. All new silos should be designed so as to be effective in Vietnam's climate.
- Benefit–cost analysis of using silos.
- Type and condition of rice to be stored in silo.
- Type and scale of warehouse or silo.
- Research for the best management system for the storage of paddy.
- Storage of rice using the plastic cover method, with carbon dioxide.
- Metabolism of rice grains after the application of carbon dioxide.
- Manufacture of jute bags for holding rice.
- Comparison of the benefit–cost of using jute bags compared with plastic bags for holding rice.
- Size of cribs (bamboo baskets, mini rice 'silos') to provide sufficient ventilation for effective storage.
- Rice and grain storage technology after drying, and quality control.
- Procedures before and during storage: integrated pest management.
- The use of postharvest pesticides in carefully controlled amounts would also be most beneficial in prolonging the storage period of rice.
- Cool room for seed rice of different cultivars.

Postharvest pests and diseases

A survey into the control of postharvest pests and diseases of rice, maize, cassava, sweet potatoes, fruit and vegetables is needed.

- Develop a quarantine system to prevent the intrusion of exotic pests and diseases such as *Prostephanus truncatus* (larger grain borer). This insect infests maize and cassava, and is only found in Central America. The damage caused by this borer is very serious.
- Control of weevils and beetles in rice.
- Control of mites in flour.
- Identify moulds that produce mycotoxins, especially aflatoxin.

Application of existing environmental pesticides

- Botanical pesticides, i.e. neem and pacynizia.
- Biological pesticides, i.e. NPV (nuclear polyhedrosis virus) to control *Spodoptera exigua* which infests vegetables, mung beans and soybeans.
- *Bacillus thuringiensis* var. Kurstaki to control young larva of butterfly.
- Pheromones could be used as an alternative to some conventional pesticides.

Milling, grading and quality control

- Types of milling machines. Small scale machines need to be developed so that each area can afford its own unit. Consignments of rice being milled need to be uniform to avoid broken rice.
- Need appropriate systems for grading rice.
- Set clear guidelines for rice grading.
- Research on factors that cause broken rice.
- Aim to achieve less broken rice after different stages of postharvest handling i.e. threshing, transporting, drying, grading, milling, and polishing.
- Increase the proportion of rice obtained by milling.

Rice by-products

Straw (stalks)

Straw is used as a cattle feed and in the production of paper (in some Asian countries), carton boxes and in growing mushrooms.

- Chemical treatment of straw to improve its digestibility for cattle.
- New techniques for growing, storage and processing straw mushrooms. The development of appropriate processing could lead to the establishment of a viable straw mushroom industry.
- Activated carbon from straw, husk, coconut fibre and coconut shell.
- Generate fuel (gas) from straw and rice husks.

Husks (hulls)

- Husks have no nutritional value, but they can be mixed with animal feed to increase bulk and roughage.
- Husks generate heat values of 3000 kcal/kg. The energy generated can be used for husk gas-engines, husk gas power generators, and husk steam power generators.
- Ash from rice husk can be collected for industrial use since rice husk contains over 30% carbon.
- Carbonised husk and coconut shell can be used to produce heat isolation materials needed in the metallurgical casting industry to increase the yield of steel.
- Some equipment could also compress ash into ash-cakes for use as charcoal.
- Smoke effluent from the system can be retained for use in the smoked-food industry.
- There are over 2000 chemical components in smoke, some of them are hazardous and should be extracted from smoke used in the food industry. Liquid smoke can be modified for sanitary use, e.g. cleaning animal cages.

Rice bran

Traditionally, rice bran was used as pig and chicken feed. It is essential to conduct further research on bran, i.e. extraction to isolate different components for different uses in cosmetics, pharmaceuticals, and industrial materials. The extraction of oil from bran increases its shelf life.

- Oil from bran can be refined into edible oil. The process of refining includes: de-gumming, de-acidification, de-waxing, de-colourisation and deodourisation.

The isolated wax can be used for the waxing of fruit and also for the production of shoe polish, wax paper and carbon paper.

- Bran also contains inositol, which can be used to treat cirrhosis of the liver and reduce high

cholesterol; oryzanol, a substance helpful in reducing serum cholesterol; and calcium phytase, which is used to stimulate the metabolism of the human body and in the treatment of neuritis.

Broken rice

Broken rice can be used in the rice processing industry.

- It can be used to produce rice paper, various types of rice noodle, rice flour, high nutrition crackers.
- It can be used to produce rice liquor which can be used as an ingredient for other foods.

Maize

- Improve storage conditions to minimise aflatoxin and insect contamination.
- Processing of maize, i.e. canning, boiling and freezing ready for use.

Cassava

- The development of processing facilities for cassava is very important for the following reasons:
  - cassava is one of the major crops in Vietnam
  - there is no export market for cassava
  - cassava changes characteristics within 24 hours after harvesting
  - prices for sliced and dried cassava are too low
  - fresh and dry cassava contain cyanides, which are toxic when consumed in large amounts
  - cassava starch can be used for consumption without toxicity problems and can also be used in industry
- Process cassava and canna into high quality starch.
- Process alcohol products from rice or cassava.
- Supplement material for medicine from cassava.
- Glue for textile industry from cassava.
- Expand extension activities to train farmers on processing.
- Further surveys on potential growing areas are required (including the North, Northern Central Coast, Central, Southern Central Coast). Suitable areas for establishing factories should be determined, taking into account labour, water, weather, transportation, and electricity.
- The development of preliminary on-site semi-processing or processing factories in the mountainous areas to maintain starch quality, to reduce wastage and to save transportation cost, is very important.
- Marketing of cassava products for industrial use including export.

Sweet potatoes

- Need to eliminate weevils from sweet potatoes. This insect produces a bitter taste and offensive characteristic smell which renders sweet potatoes unsuitable for human and animal consumption.
- Control fermentation of sweet potato leaf and vine to make a suitable stock food.
- Prolong storage life.

Other root crops

- Review on carbohydrate crops including canna.
- Process starch products from tuber crops.

Soybeans and mung beans

- Develop methods to process soybean to make soybean meal, tofu, instant tofu, soybean protein, etc.
- Process soybean to produce textured soybean protein and soybean powder.
- Prepare, ready-to-serve, frozen soybeans.
- Develop a bean-grading machine to standardise quality.

Peanuts

- Encourage the introduction of drying ovens to eliminate mould and aflatoxin.
- Develop peanut butter industry.
- Isolate and identify natural toxic components in foods i.e. aflatoxin in moulded food, glucoxinolate in brassica, eurucid acid in oil.

Coconut

- Develop coconut products as cottage industry.
- Eliminate mould from dry coconut to prevent formation of aflatoxin.
- Prevent insect contamination in dry coconut products.
- Process coconut flesh to produce coconut milk and condensed coconut milk.
- Produce coconut powder by spray drying.

- Process coconut flesh to produce desiccated coconut.
- Fatty acid in oils of coconuts, palms, peanuts, sesames, soybean, cotton oil. Refine, process and study chemical structures for different uses i.e. food, industry, soap, cosmetic, flavour.
- Hydrogenate coconut oil for industrial use.
- Produce glycerin and fatty alcohols from coconut oil.
- Glycerin can be used as a lubricating agent, moisturising or softening for cosmetics, pharmaceutical, tobacco, shoe leather and in the printing ink industries.
- Produce alkyl resins from glycerin which are used in the manufacture of paint.
- Produce nitroglycerine, an explosive from glycerin.
- Produce lubricant or surfactant from fatty alcohol.
- Fatty alcohols can be used to produce sodium lauryl sulfate which is important in the cosmetic industry.
- Produce activated carbon from coconut shell and fibre.

Sugarcane

- There is a need to process sugar cane to produce white crystalline refined sugar.
- Use sugar cane waste (cellulose fibre) as cattle feed.

Medicine material

- Prevention of the decomposition of active components of some herbal medicines.
- Extraction, isolation and identification of medically active components in natural herbs and plants.

Livestock

- Optimise the use of rice bran for livestock food.
- Process and storage of livestock food.
- Research on substitute feedstuff such as agricultural and horticultural by-products which are used in the pig and poultry industries.
- Frozen pork and poultry for export.
- Leather industry i.e. shoes, belts, bags, horse saddles.
- Duck feather (down) industry.

Fisheries

- Information on postharvest handling of seafood and procedures for storage.
- Techniques to put seafood to sleep in very cold environments when being exported.
- Suitable enzymes to speed up fish sauce production.
- Processing and storage of food for fish and prawn.
- Provision of insulated cold boxes suitable for holding fish caught from small boats. Small freezing containers would be useful when transferring fish from the small boat to the factories.
- Organise motor boats which could frequently supply small boats with ice. These boats should have refrigeration to minimise spoilage when fish are purchased from the fishers. Transportation to the factories should be completed before the onset of fish deterioration.
- Arrangement of effective receiving bays to ensure quality.
- Establishment of processing factory close to material resources.
- Investment in IQF technology suitable for large scale operations.
- For road transportation, invest in refrigerated vehicles.
- Process meat and fish products.
- De-sulfate agar using purified water to produce pure agar for use in laboratory.

CHAPTER 8

Recommendations

Proposals for Action in the Near Future

The main priority areas for research and development in Vietnam are:

- Horticultural postharvest technology.
- Horticultural products marketing.
- Rice handling, drying, storage and processing.
- Expansion of the use of rice by-products.
- Root crops management, distribution, processing and marketing.
- Industrial crops processing e.g. refining of sugar, starch modification, use of vegetable oil in the cosmetic industry.
- Dairy farm development to generate a fresh milk industry.
- Artisanal fisheries infrastructure, postharvest handling and processing.
- Medicine materials storage to minimise oxidation of components.
- Identification of natural substances that have medicinal properties.
- Packaging to prolong shelf life and improve presentation.
- Improving quality control to produce consistent uniform products.

Suggestions to ACIAR

The following topics maybe of interest to ACIAR:

- Development of rice drying infrastructure.
- Research on the management of storage systems for rice.
- The fumigation of rice in sealed plastic enclosures. The Stored Grain Research Laboratory, CSIRO Division of Entomology has worked in this area.
- Application of existing pest management methods.
- Integrated pest control.
- Extension of the use of rice by-products.
- Horticultural postharvest technology.
- Food processing, e.g. canning of meat, fish, fruit and vegetables.
- Industrial crops processing e.g. cassava starch, soybean and refining of sugar.
- Modification and use of vegetable oil, particularly coconut oil, in other industries including the cosmetic industry.
- Production of activated carbon from coconut husks.
- Transportation systems for agricultural products.
- Packaging.
- Inquire into the development of a sugar industry.
- Development of cows' milk industry.
- Handling and processing of products from artisanal fisheries.
- Liaison with other international organisations to coordinate research programs.
- Workshop on postharvest technology priorities for postharvest handling, drying, storage, processing and marketing of rice and tuber crops including cassava, canna and sweet potato.
- Training in postharvest technology.
- Assistance to upgrade agricultural high schools.

References

Can-Tho University — brochure.

Centre of Analytical Services and Experimentation — brochure.

Duong Hong-Dat, Pham Dinh-Quyen, Nguyen Thi Sam, and Vu Bich Trang 1978. Nhung Nghien Cuu Ve Bao Ve Thuc Vat. Ha-Noi, Nha Xuat Ban Khoa Hoc va Ky Thuat.

ESCAP (Economic and Social Commission for Asia and the Pacific) 1989. International Workshop on Housing. Ho-Chi-Minh City.

FAO 1985. Prevention of postharvest food losses: a training manual. Rome, FAO Training Series, 17–27.

— 1991. Vietnam industrial policy reform and international co-operation. Industrial Development Review Series, 69 p.

FAO–RAPA 1989. Selected indicators of food and agriculture development in Asia–Pacific Region, 1978–88. Bangkok, FAO–RAPA, 39–53. Cited in Hoang-Kim et al. 1992. Nghien cuu che bien va su dung san pham cay co cu lam luong thuc thuc pham gia dinh o mien Nam (Centre information).

Forest Science Institute of Vietnam 1992. Summary of the project on cashew research and technology transfer.

General Statistical Office 1992. Economy and trade of Vietnam 1986–1991. Ha-Noi, Commerce Department, Ministry of Trade and Tourism Information Centre, 5.

Hoang-Kim, Nguyen Dang Mai and Pham Van Bien 1992. Nghien cuu che bien va su dung san pham cay co cu lam luong thuc thuc pham gia dinh o mien Nam (Centre information).

Le Doan Dien 1992. Van de ton that luong thuc nong san sau thu hoach o Vietnam. Presented at international workshop on prevention of postharvest losses, organised by MAFI and ACCT, July 1992, Ho-Chi-Minh City, Vietnam.

MAFI 1985. Chuong trinh dong bo co muc tieu ve luong thuc thuc pham Vietnam nhung nam 1986–1990 va den nam 2000. Ha-Noi, MAFI, 36–38. Cited in Hoang-Kim et al. 1992. Nghien cuu che bien va su dung san pham cay co cu lam luong thuc thuc pham gia dinh o mien Nam (Centre information).

Ministry of Fisheries — outline.

— 1992. Directions and objectives for Vietnam fisheries development during 1991–2000 period. Presented at UNDP regional workshop on Vietnam fisheries development, May 1992, Ha-Noi, 29 p.

— 1992. Fisheries resources of Vietnam. Presented at UNDP regional workshop on Vietnam Fisheries Development. May 1992, Ha-Noi, 30 p.

National Foodstuff Institute — outline.

National Institute of Nutrition — outline.

Plant Protection Research Institute — outline.

Postharvest Technology Institute — outline.

Postharvest Technology Institute of South Vietnam — brochure.

Sinclair, E. and White, G. 1992. Insect pests in stored grain — a management guide for farms. Brisbane, Queensland Department of Primary Industries, 2–3.

Statistical Publishing House 1992. Statistical data of Vietnam's agriculture, forestry and fisheries (1976–1991). The pivotal areas of commodity production. Ha-Noi, 9 p.

Tong Cuc Thong Ke 1992. Nien Giam Thong Ke 1990. Ha-Noi, Nha Xuat Ban Thong Ke, 5–6.

TDC (Trade Development Counci) Research Staff 1992. Vietnam's market profile. Hongkong, Trade Development Council. International Market News, 84 and 34.

Thu-Duc University of Agriculture and Forestry — brochure.

Tra-Vinh Department of Agriculture 1992. Statistical figures of 1990, budget planning for 1995.

Tran Hoang-Kim 1992. Economy of Vietnam reviews and statistics. Ha-Noi, Statistical Publishing House, 138 p.

Tuoi-Tre 1992, Vietnam. 25th June.

UNDP 1991. Vietnam industrial reform and international co-operation. Industrial Development Review Series, 52 p.

— and Vien Khoa Hoc Lam Nghiep Vietnam 1989. Research and development of cashew nut. Ky thuat san xuat va bien che dieu.

UNIDO 1991. Vietnam industrial policy reform and international co-operation. Industrial Development Review Series, vii p.

Vegetexco Ho-Chi-Minh City — brochure.

Vietnam Agricultural Science Institute — brochure.

Vietnam Agricultural Science Institute of South Vietnam — brochure.

Vikyno Factory — outline.

WHO and Institute of Materia Medica 1990. Medicinal Plants in Vietnam. Manila and Ha-Noi, WHO Regional Publications, Western Pacific Series, No. 3.

Appendixes

Appendix 1

Itinerary of Dr M.Y. Lam, ACIAR project 'Food Research in Vietnam' Vietnam, 12 August–15 October 1992

Wednesday
12–8–92 – Arrived at Noi-Bai airport.

Friday
14–8–92 – Attended meeting with the Vice Minister for Agriculture and Food Industry (MAFI), Prof. Vu Tuyen Hoang at Ngoc-Ha Street.
– Attended meeting with the Deputy Director of International Cooperation Department (MAFI), Mr Nguyen Ich Chuong.
– Visited the National Institute of Open Learning and Distance Education (VNIOLDE).
– Attended meeting with the Director of Department of Agricultural Science & Technology (MAFI), Prof. Nguyen Ngoc Kinh.

Saturday
15–8–92 – Visited Vietnam Agricultural Science Institute (VASI), An-Khanh, Hoai-Duc, Ha-Tay. Met Prof. Nguyen Dang Khoi, Deputy Director.
– Visited Council of Ministers.

Monday
17–8–92 – Visited Plant Protection Research Institute, Tu-Liem, Ha-Noi. Prof Ha Minh Trung, Deputy Director.
– Visited State Science Committee to discuss National Integrated Rural Development Programme.

Tuesday
18–8–92 – Visited Postharvest Technology Institute, Ngo Quyen, Ha-Noi. Met Prof Le Doan Dien, Director.
– Attended meeting with the Deputy General Director of State Planning Committee (SPC), Mr Duong Duc Ung.
– Visited Institute for Soils and Fertilisers, Tu-Liem, Ha-Noi. Met Prof Thai-Phien, Vice Director.
– Invited to meeting with General Vo Nguyen Giap and the Minister of Agriculture, Mr Nguyen cong Tan.

Wednesday
19–8–92 – Visited Ministry of Forestry, International Cooperation Dept, Lo-Duc, Ha-Noi. Met Mr Ngo Si Hoai.
– Visited Forestry Science Institute, Tu-Liem, Ha-Noi. Met Prof Vu Biet Linh, Director.

Thursday
20–8–92 – Attended meeting with the Director of Department for Scientific and Technical Cooperation with Foreign Countries, State Committee for Sciences (SCS), Tran-Hung-Dao St, Ha-Noi, Mr Dau Dinh Loi.

Friday
21–8–92 – Departed Ha-Noi.
– Arrived at Ho-Chi-Minh City.
– Visited Centre of Nuclear Techniques, Nguyen-Trai, Ho-Chi-Minh City. Met Dr Ngo Quang Huy, Director.
– Visited Institute of Agricultural Science of South Vietnam, Nguyen Binh Khiem, Ho-Chi-Minh City. Met Prof. Tran The Thong.

Saturday
22–8–92 – Visited University of Agriculture and Forestry, Ho-Chi-Minh City. Met Prof. Doan Van Dien, Director.
– Visited experimental farms of the University of Agriculture and Forestry.

Sunday
23–8–92 – Departed Ho-Chi-Minh City for Can-Tho, accompanied by Mr Tran Kim Tinh, Head of Soil Sciences Department.
– Observed the plain of reeds in Long-An province, and inspected crops in Tien-Giang province.
– Met the Rector, Prof. Tran Phuoc Duong at Can-Tho University.

Monday
24–8–92 – Visited Can-Tho University, and had discussions with appropriate officers of:
. Home Garden Program,
. Agronomy Faculty,
. Acid Sulphate Soil Department,
. Biotechnology Research Centre,
. Food Processing Department.

Tuesday
25–8–92 – Departed Can-Tho
– Arrived at Ho-Chi-Minh City.
– Visited Forestry Science Sub Institute. Met the Vice Minister of Forestry, Mr Phan Thanh Xuan.

Wednesday
26–8–92 – Departed Ho-Chi-Minh City.
– Arrived at Bao-Loc, Lam-Dong province.

Thursday
27–8–92 – Visited Bao-Loc Forestry Centre.
– Visited Sericulture Experimentation Centre.
– Departed Bao-Loc.
– Arrived at Da-Lat, Lam-Dong province.

Friday
28–8–92 – Visited Da-Lat University, had discussions with Mr Phan Nam, Vice Director.
– Visited Lam-Dong Forestry Research Centre.
– Visited Da-Lat market, observed sub-tropical fruits, vegetables, tuber crops and preserved fruit.

Saturday
29–8–92 – Departed Da-Lat.
– Arrived at Ho-Chi-Minh City.

Monday
31–8–92 – Visited Postharvest Technology Sub Institute, had discussions with Prof. Le Van To, Director.
– Visited University of Agriculture and Forestry, had discussions with Prof. Doan Van Dien, the Rector and Prof. Dao The Tuan, VASI Director.

Tuesday
1–9–92 – Visited Regional Centre For Standardisation and Quality Control, had discussions with Dr Nguyen Huu Thien, Director.
– Visited VINATEST Instrument Service Centre.

Wednesday
2–9–92 – Visited Vietnam Engine and Agricultural Machinery Corporation, (VIKYNO), had discussions with Dr Dang Minh Trang, Director.
– Visited AGRINCO (Advisory And Technical Electro Mechanisation Investment Company of Agriculture and Food Industry), had discussions with Dr Tran Quan, Director.

Thursday
3–9–92 – Visited Technology Development Company, had discussions with Dr Dang Quan Duc, Director on the manufacturing of jute bags for use as rice containers in Vietnam.

Friday
4–9–92 – Visited Standardisation and Quality Control, Food Control Department.
– Visited Postharvest Technology Sub. Institute, processing machinery, Thu-Duc.

Saturday
5–9–92 – Visited Coastal Fisheries Development Company, had discussions with Mr Vo Hue Tran, Director.
– Visited Duyen-Hai Aquaculture Enterprise, Can-Gio, Duyen-Hai, had discussions with Mr Nguyen Pham Thanh, Director.

Sunday
6–9–92 – Departed Ho-Chi-Minh City.
– Arrived at Can-Tho province.

Monday
7–9–92 – Visited Can-Tho University, and had discussions with appropriate officers of:
. Agronomy Faculty.
. Food Processing Faculty
. Aquaculture Department.

Tuesday
8–9–92 – Departed Can-Tho province.
– Arrived at Vinh-Long province.
– Visited The People's Committee of Vinh-Long had discussions with Mr Tu and Mr Nam, Chairman and Vice Chairman.
– Visited Agricultural Department of Vinh-Long, had discussions with Mr Lam Van Tin, Director.

Wednesday
9–9–92 – Arrived at Tra-Vinh province.
– Visited The People's Committee of Tra-Vinh had discussions with Mr Tran Van Ven, Vice Chairman.
– Visited Tra-Vinh Department of Agriculture. Had discussions with Mr Nguyen Van Day, Director.
– Visited Tra-Vinh oil refinery.
– Visited Tam-Phuong Water Control Project.
– Observed rice harvesting and rice threshing machine at Tam-Phuong.
– Visited Satake Milling Company, Tam-Phuong, had discussions with Mr Triet, Director.
– Back to Can-Tho province.

Thursday
10–9–92 – Visited Song-Hau 1st Grade Food Company, had discussions with Mr Pham Trung Viet, Vice Director.

- At Can-Tho University, visited appropriate faculties and departments of:
  . Plant Protection Department, had discussions with Dr Pham Van Kim, Deputy Dean of the Faculty.
  . Agricultural Engineering Faculty, had discussions with Mr Vu Quang Thanh, Dean of the Faculty.
  . Food Industry Department.
  . Cultivation System Research and Development Centre.

Friday

11–9–92 – Attended Opening Ceremony of the new academic year of Can-Tho University, had discussions with the Vice Rector, Prof. Vo Tong Xuan.
- Visited Can-Tho Agricultural High school, had discussions with Mr Vui, the Principal and Mr Pham van Sem, the Vice Principal.
- Visited The People's Committee of Can-Tho province, had discussions with Mr Huynh Cong Dai, Chairman and Mr Le Trung Vinh, Vice Chairman.
- Visited Can-Tho Department of Agriculture, had discussions with Mr Nguyen Van Ngau, Vice Director, Plant Protection and Extension.
- Visited Can-Tho Science and Technology Department, had discussions with Mr Bui Minh Tao, Vice Head of the Department.

Saturday

12–9–92 – Had discussions with Prof. Tran Phuoc Duong when travelling from Can-Tho to Ho-Chi-Minh City.
- Visited Vinh-Long Technology High School.
- Observed barges used for transportation on Mekong River.
- Observed mobile milling machine and farmer's rice storage facilities.

Monday

14–9–92 – Departed Ho-Chi-Minh City.
- Arrived at Ha-Noi.
- Visited State Committee for Science, had discussions with Dr Nguyen Van Thu, Dr Nguyen Ngoc Tien and Mr Trinh Nguyen Huan.

Tuesday

15–9–92 – Visited State Science Committee, had discussions with:
  . Prof. Dao The Tuan, Vietnam Agricultural Science Institute Director.
  . Mr Nguyen Si Loc, United Nations Inter-Regional Project.

Wednesday

16–9–92 – Visited Ministry of Agriculture and Food Industry.
- Visited National Institute of Nutrition, had discussions with Prof. Tu Giay and Dr Pham Van Hoan.

Thursday

17–9–92 – Visited FAO library.
- Visited Plant Protection Institute, had discussions with Dr Ha Minh Trung, Deputy Director.

Friday

18–9–92 – Visited Postharvest Technology Institute, had discussions with Prof. Le Doan Dien, Director.
- Visited Industrial Foodstuff Institute, had discussions with Dr Nguyen Bao Toan, Director.

Saturday

19–9–92 – Visited Ministry of Fisheries, Ba-Dinh, Ha-Noi, had discussions with the officers of:
  . International Cooperation Department. Ms Tran Thi Minh Hue.
  . Department of Science and Technology, Ing. Dinh Trong Hai, Deputy Director, and Ms Nguyen Phuong Lan.
  . Information Centre for Sciences and Technology. Dr Phan Trong Hau, Director.

Monday

21–9–92 – Visited Food and Agriculture Organisation (FA0), to meet Dr Jacqui Badcock. Also had discussions with Mr Nguyen Huy Dinh and latter with Dr Siegfried Lampe, Regional Coordinator and Mr Alain L.Ange, Service Chief.

Tuesday

22–9–92 – Visited Ministry of Trade and Tourism, Research Institute for Foreign Economic Relations, Market Research Division, had discussions with Dr Tran Dinh Ap, Manager.

Wednesday

23–9–92 – Visited the Institute of Marine Product Research, Hai-Phong province, had discussions with Prof. Bui Dinh Chung, Director, and Eng. Nguyen Van Ngoan, Deputy Director.
- Visited Hai-Phong Export Sea Products Processing Enterprise, had discussions with Ms Nguyen Thi Phi Yen, Director.

Thursday
24–9–92 – Visited Medicine Material Institute, had discussions with Prof. Le Tung Chau , Vice Director.
– Visited State Science Committee, had discussions with Prof. Nguyen Van Thuong, Director of National Project for Animal Husbandry.

Friday
25–9–92 – Departed Ha-Noi.
– Arrived at Ho-Chi-Minh City.

Monday
28–9–92 – Visited Technology Development Company, had discussions with Dr Dang Quan Duc, Director.

Tuesday
29–9–92 – Visited Ministry of Fisheries, had discussions with Mr Huynh Cong Hoa, Vice Minister.

Wednesday
30–9–92 – Attended seminar held at the Plastics Technology Centre, Dr Luong Bach Van, Director.

Thursday
01–10–92 – Visited cashew nut factory, a subsidiary of the Ministry of Forestry, had discussions with Mr Thao, Director.

Friday
2–10–92 – Visited Ministry of Fisheries.
– Visited United Nations Development Program (UNDP), Packaging Technology Development Centre, had discussions with Mr M. R. Subramanian, Program Co-ordinator.

Saturday
3–10–92 – Visited VIKYNO, had discussions with Dr Dang Minh Trang, Director.
– Visited Institute of Agricultural Science, had discussions with Prof. Tran The Thong, Director.

Monday
5–10–92 – Visited Vietnam Agricultural Science Institute, had discussions with Prof. Tran The Thong, Director.

Tuesday
6–10–92 – Visited Postharvest Technology Institute, had discussions with Prof. Le Van To, Director.

Wednesday
7–10–92 – Visited Hung-Loc Agricultural Research Centre, Dong-Nai, had discussions with Mr Nguyen Quy Thuc, Director, and Dr Hoang Kim, Vice Director.
– Visited cassava plantation, Tra–Co, had discussions with Mr Nguyen Ngoc Thach, farmer.
– Visited tapioca processing factory, had discussions with Mr Nguyen Van Luat, owner.
– Visited sago processing factory, discussions with Mr Dao, owner.

Thursday
8–10–92 – Visited Song-Be Animal Husbandry Centre, had discussions with Mr Nguyen Quoc Tien, and Mr Nguyen Ngoc Hung.
– Visited Finaco Poultry Farm, had discussions with Mr Tran Van Lieu, Director.
– Visited Song-Be Department of Agriculture, had discussions with Mr Nguyen Van Tai, Director.
– Visited pepper plantation, Song-Be province.
– Visited the 19-8 Poultry and Quail Farm, Thuan An, Song-Be, had discussions with Ms Vo Thi Ngoc Lan, Director.

Friday
9–10–92 – Met Mr Tran Kim Tinh of Can-Tho University.

Tuesday
13–10–92 – Visited External Relations Services office.
– Visited Home Affairs office.

Wednesday
14–10–92 – Departed Ho-Chi-Minh City.

Thursday
15–10–92 – Arrived at Melbourne.

Appendix 2

Institutions visited

Institutions visited, addresses and names of people with whom the author had discussions.

Ha-Noi Province

General Vo Nguyen Giap.

Council of Ministers Office

(Hoang-Dieu, Ha-Noi)
Mr Trinh Nguyen Huan, Deputy Director.

State Planning Committee (SPC)

(Hoang Van Thu, Ha-Noi)
Mr Duong Duc Ung, Deputy General Director.

Foreign Economic Relations Department
(Hoang-Dieu, Ha-Noi)
Mr Pham Hoang Mai, Manager.

State Committee for Sciences (SCS)

Department for Scientific and Technical Cooperation with Foreign Countries
(Tran-Hung-Dao, Ha-Noi)
Mr Dau Dinh Loi, Director,
Dr Vu van Trieu.

National Institute for Scientific and Technological Forecasting and Strategy Studies (NISTFASS)
(Ngo-Quyen, Ha-Noi)
- Department of administration
  Dr Nguyen Ngoc Tien, Chief of Department.
- Computer group
  Mr Nguyen Xuan Hieu.

National Integrated Rural Development Program (NIRUDEP)
(Ngo-Quyen, Ha-Noi)
Dr Nguyen Van Thu, Program Coordinator,
Miss Mai Anh,
Miss Lieu.

United Nations Inter-Regional Project
(Ngo-Quyen, Ha-Noi)
Mr Nguyen Si Loc, National Project Coordinator.

Food and Agriculture Organization of the United Nations (FAO)

(Nguyen Gia Thieu, Ha-Noi)
Dr Siegfried Lampe, Regional Coordinator,
Mr Alain L. Ange, Service Chief,
Dr Jacqui Badcock, Program Officer,
Mr Nguyen Huy Dinh, National Program Officer,
Mr Chris Landon-Lane, Horticulturist.

Ministry of Agriculture and Food Industry (MAFI)

(Bach-Thao, Ha-Noi)
Dr Nguyen Cong Tan, Minister,
Prof. Dr Vu Tuyen Hoang, Vice Minister,
Dr Nguyen Thien Luan, Vice Minister.

Department of Agricultural Science and Technology
Prof. Dr Nguyen Ngoc Kinh, Director,
Prof. Dr Do Anh,
Eng. Bui Huy Tuong, Vice Director,
Eng. Phi Manh Hung.

Department of International Cooperation
Mr Nguyen Ich Chuong, Vice Director,
Dr Nghiem Chung Lan, Vice Director,
Ms Nguyen To Tam, Vice Director,
Mr Nguyen Dang Sung, Assistant to Director,
Ms Nguyen Thi Kim Thinh, Program Officer,
Ms Hoang Thi Dung, Interpreter.

Vietnam Agricultural Science Institute (VASI)
(Phuong-Mai, Dong-Da, Ha-Noi)
Prof. Dr Dao The Tuan, Director,
Prof. Dr Nguyen Dang Khoi, Deputy Director,
- Soil Chemistry Department
  Dr Le Van Tiem,
  Mr Thieu.
- Legume Research and Development Centre
  Prof. Dr Tran Van Lai, Director. (Also Chairman of National Program of Food Legumes Development).
- Biotechnology Department
  Dr Ho Huu Nhi.
- Plant Pathology Department
  Dr Nguyen Xuan Hong.
- Centre of Agricultural Technology Transfer
  (Thanh-Tri, Ha-Noi)
  Mr Mai Van Thiet, Vice Director.

National Institute of Agricultural Science
(Van-Dien, Ha-Noi)
- Potato And Vegetable Research Centre
  Mr Truong Dinh Ho, Director,
  Mr Dao Duy Chien, Vice Director,
- Plant Introduction Centre
  Dr Tran Dinh Long, Director.

Plant Protection Research Institute (PPRI)
(Chem, Tu-Liem, Ha-Noi)
Dr Le Van Thuyet, Director,
Prof. Ha Minh Trung, Deputy Director.
- Scientific Division
  Mr Dinh Van Thanh.
- Pesticide Weed Control Department
  Prof. Hoang Anh Cung, Head of Department,
  Nguyen Duy Trang, Vice Chief of Department.
- Scientific Division
  Dr Nguyen Van Thieng, Head of the Division.

Biocontrol Research Centre (Part of PPRI)
(Dong-Ngac, Tu-Liem, Ha-Noi)
Prof. Truong Thanh Gian, Director. (Also Deputy Director of PPRI),
Prof. Nguyen Van Cam, Vice Director,
Mr Tran Dinh Pha, Entomologist.

Institute for Soils and Fertilisers (ISF)
(Tu-Liem, Ha-Noi)
Prof. Thai Phien, Vice Director,
Prof. Nguyen Tu Siem.

Postharvest Technology Institute
(Ngo-Quyen, Ha-Noi)
Prof. Le Doan Dien, Director. (Also President of Biochemistry Society).
Dr La Van Chu, Vice Director.

Industrial Foodstuffs Institute
(Nguyen-Trai, Ha-Noi)
Dr Nguyen Bao Toan, Vice Director,
Dr Hoang Duc Nhu,
Eng. Quy,
Eng. Mui,
Eng. Hung,
Eng. Thanh.

National Institute of Nutrition (NIN)
(Tang-Bat-Ho, Ha-Noi)
Prof. Tu Giay, Director,
Dr Pham Van Hoan.

Materia Medica Institute
(Quang-Trung, Ha-Noi)
Prof. Le Tung Chau, Vice Director,
Mr Nguyen Bao Hung.

Animal Husbandry Association of Vietnam
(Phuong-Mai, Dong-Da, Ha-Noi)
Prof. Nguyen Van Thuong, Director.

Ministry of Forestry

International Cooperation Department
(Lo-Duc, Ha-Noi)
Mr Ngo Si Hoai.

Forest Science Institute
(Chem, Tu-Liem, Ha-Noi)
Prof. Vu Biet Linh, Director.
- Science Planning and Training Division
  Eng. Doan Bong, Head of Division.

Ministry of Fisheries
(Ba-Dinh, Ha-Noi)

International Cooperation Department
Ms Tran Thi Minh Hue.

Science and Technology Department
Eng. Dinh Trong Thai, Deputy Director,
Ms Nguyen Phuong Lan.

Information Centre for Sciences and Technology
Dr Phan Trong Hau, Director.

Ministry of Trade and Tourism

Research Institute for Foreign Economic Relations
(Ngo-Quyen, Ha-Noi)
- Marketing and Market Research Division
  Dr Tran Dinh Ap, Manager,
  Mrs Nguyen Thi Nhieu, Deputy Manager,
  Mr Nguyen Ngoc Anh,
  Mrs Le Thi Hoa.

Hai-Phong Province

Marine Products Research Institute
(Le-Lai, Hai-Phong)
Prof. Bui Dinh Chung, Director,
Eng. Nguyen Van Ngoan, Deputy Director,
Dr Tran Duc Thoan,
Mr Nguyen Van Be,
Ms Nguyen Thi Phuong.

Science and Technology Department
Mr Nguyen Van Dung,
Mr Nguyen Quang Nhung.

Hai-Phong Export Seaproducts Processing Enterprises
(Vo Thi Sau, Hai-Phong)
Ms Nguyen Thi Phi Yen, Director.

Lam Dong Province

Bao-Loc Forestry Centre
(Bao-Loc, Lam-Dong)

Sericulture Experimentation Centre
(Bao-Loc, Lam-Dong)

Da-Lat University
(Da-Lat, Lam-Dong)
Mr Phan Nam, Vice Director.
Lam-Dong Forestry Centre

Song-Be Province

Department of Agriculture, Forestry and Irrigation
(Thu-Dau-Mot, Song-Be)
Nguyen Van Tai, Director,
Mr Tam, Vice Director.

Animal Husbandry Centre
Mr Nguyen Quoc Tien,
Mr Nguyen Ngoc Hung.

FINACO Poultry Company
Mr Tran Van Lieu, Director,
Mr Kinh.

19–8 Poultry and Quail Company
(Thuan-An, Song-Be)
Ms Vo Thi Ngoc Lan, Director.

Song-Be pepper plantation

Dong-Nai Province

Hung-Loc Agricultural Research Centre
(Hung-Loc, Dong-Nai)
Mr Nguyen Qui Thuc, Director,
Mr Hoang Kim, Vice Director.

Cassava plantation
(Tra-Co, Dong-Nai)
Mr Nguyen Ngoc Thach.

Tapioca processing factory
(Tra-Co, Dong-Nai)
Mr Nguyen Van Luat.

Sago processing factory
Mr Dao.

Ho-Chi-Minh City

Institute of Agricultural Science of South Vietnam
(Nguyen Binh khiem, Ho-Chi-Minh City)
Prof. Tran The Thong, Director. (Also Member of National Council of Policy-Science-Technology),
Dr Pham Van Bien, Vice Director,
Dr Vu Thi Nhu, Vice Director,
Mr Mai Van Quyen, plant physiologist.

University of Agriculture and Forestry IV
(Thu-Duc, HCM City)
Prof. Doan Van Dien, Rector,
Prof. Trinh Xuan Vu, Vice Rector,
Dr Luu Trong Hieu.

Centre of Nuclear Technology
(Nguyen-Trai, Ho-Chi-Minh City)
Dr Ngo Quang Huy, Director,
Mr Le Dac Lieu, Director.
– Radiobiology Department
Mr Vo Huy Dang.

Postharvest Technology Institute, Ho-Chi-Minh City Office
(Pasteur, Ho-Chi-Minh City)
Prof. Le Van To, Director.
– Mechanical Design Department
Eng. Truong Quang Minh, Chief of the Dept.

Regional Centre for Standardisation Metrology and Quality Control
(Pasteur, Ho-Chi-Minh City)
Dr Nguyen Huu Thien, Director.
– Food Control Department
Eng. Tran Van Dung, Head of the Dept.

Vinatest-Instrumentation Service Centre
(Pasteur, Ho-Chi-Minh City)
Mrs Ngo Thi Hong Thu, Manager.

Food Industries Research Institute
(Nguyen Binh Khiem, Ho-Chi-Minh City)
Dr Hoang Duc Nhu, Vice Director.

Plastics Technology Centre
(Nam-Ky Khoi-Nghia, Ho-Chi-Minh City)
Dr Luong Bach Van, Director.

Forest Science Sub-Institute of South Vietnam
(Pham Van Hai, Ho-Chi-Minh City)
Mr Ngo Duc Hiep, Deputy Director.
– Cashew Research and Development
Mr Vo Si Hoang.
– Cashew nut processing factory
Mr Thao, Director.

Vikyno-Vietnam Engine and Agricultural Machinery Corporation
(Bien-Hoa Industrial Zone)
Dr Dang Minh Trang, Director,
Mr Nguyen Van Binh, Deputy Manager,
Mr Le Anh Tai, Deputy Manager.

Technology Development Company (TEDCO)
(Ly Chinh Thang, Ho-Chi-Minh City)
Dr Dang Quan Duc, Director.

Agrinco
(Advisory and Technical Electro Mechanisation Investment Company of Agriculture and Food Industry)
(Tran Nhat Duat, Ho-Chi-Minh City)
Mr Tran Quan, Director.

Ministry of Fisheries

Mr Huynh Cong Hoa, Vice Minister.

Coastal Fisheries Development Company (COFIDEC)
(Tu Xuong, Ho-Chi-Minh City)
Mr Vo Hue Tran, Director.

United Nations Development Program (UNDP)
(Ong Ich Khiem, Ho-Chi-Minh City)
Mr M. R. Subramanian, Chief Technical Adviser.

Duyen-Hai District, Ho-Chi-Minh City

Cofidec Duyen-Hai Aquaculture Enterprise
(Can-Gio, Duyen-Hai)
Mr Nguyen Pham Thanh, Director.

Long-An Province

Visited Plain of Reeds.

Tien-Giang Province

Examined field crops.

Dong-thap Province

The Education and Training Service of Dong-Thap
(Vo Truong Toan St., Dong-Thap)
Mr Le Vu Hung, Director.

Can-Tho Province

The People's Committee of Can-Tho
(Phan Dinh Phung, Can-Tho)
Mr Huynh Cong Dai, Chairman,
Mr Le Trung Vinh, Vice Chairman,
Mr Dang Cong Hoan,
Mr An,
Mr Doi,
Mr Nhan,
Mr Oai.

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(Ngo Duc Ke, Can-Tho)
Mr Nguyen Van Ngau, Vice Director.

Can-Tho Science and Technology Department
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Mr Bui Minh Tao, Vice Head of Department.

Can-Tho University
Prof. Tran Phuoc Duong, Rector.
Prof. Vo Tong Xuan, Vice Rector. (Also is a member of the Board of Trustees member of the International Rice Research Institute)

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  Dr Pham Van Kim, Deputy Dean of Faculty.
  . Plant Protection Department
  Dr Pham Van Kim, Head of the Dept.
  . Crop Science Department
  Mr La Thanh Phuong,
  . Acid Soil Department
  Mr Tran Kim Tinh, Head of the Dept,
  Mr Le Quang Tri.
  . Plant Breeding Department
  Mr Vuong Dinh Tri.
  . Farming System Research and Development Centre
  Mr La Thanh Duong.
- Food Processing Faculty
  Mr Bui Huu Thuan.
- Food Industry Department
  Mr Pham Minh Hau,
  Mr Vu Truong Son,
  Mr Vo Tan Thanh.
- Agricultural Engineering Faculty
  Mr Vu Quang Thanh, Dean of Faculty.
- Fisheries Faculty
  . Aquaculture Department
  Mr Nguyen Anh Tuan, Head of Dept
- Home Garden Program
  Mr Vuong Dinh Tri.
- Biotechnology Research and Development Centre
  Mr Cao Ngoc Diep,
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Mr Vui, Principal,
Mr Pham Van Sem, Deputy Principal.

Song-Hau First Grade Food Company
(Tra-Noc Industrial Zone)
Mr Pham Viet Trung, Deputy Director.

Vinh-Long Province

The People's Committee of Vinh-Long
Mr Nam, Chairman,
Mr Tu, Vice Chairman,
Mr Tran Huu Tin, Member of Parliament.

Agricultural Service of Cuu-Long Province
Mr Tran Huu Tin, Director,
Mr Chien, Horticulture.

Vinh-Long Technology High School
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Mr Bien Cong Hai, Deputy Principal

Tra-Vinh Province

The People's Committee of Tra-Vinh Province
Mr Tran Van Ven, Vice Chairman,
Mr Nguyen Ba Hieu, Vice Chairman.

Tra-Vinh Department of Agriculture
Mr Dong, Director.

Land Management Section
Mr Huynh Khac Thanh,
Ms Nhung.

Tra-Vinh Oil Refinery Plant

Tam-Phuong Water Control Project

Satake Milling Company, Tam-Phuong
Mr Triet, Director.

Appendix 3

Vietnam: Area, Population and Population Density

Regions/provinces	Town (under province)	Area (km^2)	Population ('000)	Density (people per km^2)
Total		331 033	66 233	200
Northern Regions		166 582	33 128	199
North Montane & Midland		102 938	11 260	109
* Ha-Tuyen				
. Ha-Giang &	Ha-Giang	5 802	476	82
. Tuyen-Quang	Tuyen-Quang	7 830	583	74
. Cao-Bang	Cao-Bang	8 445	581	69
. Lang-Son	Lang-Son	8 167	624	76
. Lai-Chau	Lai-Chau	17 140	453	26
* Hoang-Lien-Son				
. Lao-Kai &	Lao-Kai	8 045	477	59
. Yen-Bai	Yen-Bai	6 807	595	87
. Bac-Thai	Thai-Nguyen	6 503	1 060	163
. Son-La	Son-La	14 210	703	49
* Ha-Son-Binh				
. Ha-Tay &	(see under Red River Delta)			
. Hoa-Binh	Hoa-Binh	4 613	674	146
. Quang-Ninh	Hon-Gai	5 939	831	140
. Vinh-Phu	Viet-Tri	4 823	2 081	431
. Ha-Bac	Bac-Giang	4 615	2 122	460
Red River Delta		12 466	13 025	1 045
. Ha-Noi (Capital)		934	2 052	2 198
. Hai-Phong City		1 504	1 483	986
. Ha-Tay	Ha-Dong	2 143	2 090	975
. Hai-Hung	Hai-Duong	2 552	2 503	981
. Thai-Binh	Thai-Binh	1 524	1 673	1098
* Ha-Nam-Ninh				
. Ha-Nam &	Nam-Dinh	2 424	2 436	1 000
. Ninh-Binh	Ninh-Binh	1 389	788	567
Central Coast		51 178	8 842	173
. Thanh-Hoa	Thanh-Hoa	11 168	3 081	276
* Nghe-Tinh				
. Nghe-An &	Vinh	16 371	2 498	153
. Ha-Tinh	Ha-Tinh	6 055	1 202	183
. Quang-Binh	Dong-Hoi	7 983	680	85
. Quang-Tri	Dong-Ha	4 592	479	104
. Thua-Thien-Hue	Hue	5 009	903	180

Continued on next page

Regions/provinces	Town (under province)	Area (km^2)	Population ('000)	Density (people per km^2)
Southern Regions		164 451	32 061	195
Central Coast		45 824	6 846	149
. Quang-Nam-Da-Nang	Da-Nang	11 988	1 793	149
. Quang-Ngai	Quang-Ngai	5 856	1 072	183
. Binh-Dinh	Qui-Nhon	6 076	1 270	209
. Phu-Yen	Tuy-Hoa	5 223	663	127
. Khanh-hoa	Nha-Trang	5 258	845	161
* Thuan-Hai		11 422	1 203	105
. Binh-Thuan &	Phan-Rang			
. Ninh-Thuan	Phan-Thiet			
Central Highlands		55 569	2 597	47
* Gia-Lai Kon-Tum				
. Gia-Lai &	Pleiku	15 278	671	44
. Kon-Tum	Kontum	10 318	230	22
. Dac-Lac	Ban-Me-Thuot	19 800	1 026	52
. Lam-Dong	Da-Lat	10 173	670	66
North East		23 484	8 020	341
. Ho-Chi-Minh City		2 090	4 005	1 917
. Song-Be	Thu-Dau-Mot	9 546	978	102
. Tay-Ninh	Tay-Ninh	4 027	811	201
. Dong-Nai	Bien-Hoa	5 868	1 632	278
. Ba-Ria Vung-Tau	Vung-Tau	1 954	594	304
Mekong River Delta		39 575	14 598	369
. Long-An	Tan-An	4 338	1 151	265
. Dong-Thap	Sa-Dec	3 276	1 373	419
. An-Giang	Long-Xuyen	3 424	1 847	539
. Tien-Giang	My-Tho	2 339	1 524	651
. Ben-Tre	Ben-Tre	2 247	1 242	552
* Cuu-Long		3 856	1 864	483
. Vinh-Long &	Vinh-Long			
. Tra-Vinh	Tra-Vinh			
* Hau-Giang		6 161	2 758	448
. Can-Tho &	Can-Tho			
. Soc-Trang	Soc-Trang			
. Kien-Giang	Rach-Gia	6 243	1 235	198
. Minh-Hai	Ca-Mau	7 689	1 605	209

* Name of former provinces before being divided into 2 provinces, i.e. Ha-Giang and Tuyen-Quang was Ha-Tuyen.

Sources: Tong Cuc Thong Ke 1992: 5–6.
General Statistical Office 1992: 40–42.
Tran Hoang-Kim 1992: 88–89.

Appendix 4

Average annual temperatures in Vietnam

City/ town	Hot season	Cool season	Annual
	Average (°C)		
Ha-Noi	29.2	17.2	23.2
Hue City	29.3	20.5	24.9
Ho-Chi-Minh City	29.7	24.0	27.8
Sa-Pa Town	20.1	8.3	14.3
Da-Lat City	20.5	17.2	18.9

Source: General Statistical Office 1992:9.

Appendix 5

Average annual rainfall in Vietnam

City/ town	Rainy season	Dry season	Annual
	Average (mm)		
Ha-Noi	1530	270	1800
Hue City	2320	580	2900
Ho-Chi-Minh City	1800	200	2000

Source: General Statistical Office 1992: 9.

Appendix 6

Gross agricultural value, crops and livestock (percent)

Year	Crop production	Livestock production
1976	80.7	19.3
1980	78.7	21.3
1985	75.4	24.6
1990	74.3	25.6
1991	74.5	25.5

Note: All figures in terms of 1989 prices.
Source: Statistical Publishing House 1992: 5.

Appendix 7

Gross agricultural value, various crops (percent)

Year	Food crops	Vegetables	Industrial crops	Fruit
1985	70.0	4.1	14.4	7.6
1986	68.7	4.6	14.7	8.2
1987	67.5	4.8	15.8	8.3
1988	69.9	4.3	15.1	7.0
1989	71.2	4.3	13.8	7.0
1990	70.5	4.3	14.0	7.7

Source: Tong Cuc Thong Ke 1992: 73.

Appendix 8

Areas of crops grown ('000 ha)

Year	Annual crops				Perennial crops	
	Total	Food	Vegetables	Industrial	Industrial	Fruit
1980	8251.0	7049.3	299.6	371.7	256.0	185.6
1985	8556.8	6833.6	369.0	600.7	470.3	213.0
1986	8606.1	6812.3	400.5	601.0	498.9	261.2
1987	8641.7	6709.9	409.8	637.6	574.7	278.0
1988	8883.5	6967.8	401.2	601.0	611.9	272.2
1989	8978.2	7089.6	419.5	543.7	625.1	281.7
1990	9040.0	7110.9	426.1	542.0	657.3	281.2

Source: Tong Cuc Thong Ke 1992: 73–74

Appendix 9

Area of crops by share (percent)

Year	Annual crops			Perennial crops	
	Food	Vegetables	Industrial	Industrial	Fruit
1980	85.4	3.6	4.5	3.1	2.2
1985	79.9	4.3	7.0	5.5	2.5
1986	79.2	4.6	7.0	5.8	3.0
1987	77.6	4.7	7.4	6.6	3.2
1988	78.4	4.5	6.8	6.9	3.1
1989	79.0	4.7	6.1	7.0	3.1
1990	78.7	4.7	6.0	7.3	3.1

Source: calculated from Appendix 8.

Appendix 10

Crop production by region ('000 t)

Region	Production		
	1988	1989	1990
Whole country	19 583.1	21 515.6	21 488.5
Northern regions	8 369.4	8 954.6	8 448.4
North Montane & Midland	2 473.5	2 720.2	2 349.6
Red River Delta	3 993.5	4 289.3	4 100.7
Central Coast	1 902.4	1 945.1	1 998.1
Southern regions	11 213.7	12 561.0	13 040.1
Central Coast	1 820.8	1 883.9	1 875.6
Central Highland	562.5	596.8	581.0
North East	1 087.0	1 055.9	975.7
Mekong River Delta	7 743.4	9 024.4	9 607.8

Source: Tong Cuc Thong Ke 1992: 75–76.

Appendix 11

Crop growing areas by egion ('000 ha)

Region	Growing area		
	1988	1989	1990
Whole country	6 967.8	7 089.6	7 110.9
Northern regions	3 302.7	3 311.9	3 223.8
North Montane & Midland	1 106.7	1 117.0	1 087.8
Red River Delta	1 287.5	1 289.4	1 246.9
Central Coast	908.5	905.5	889.1
Southern regions	3 665.1	3 777.7	3 887.1
Central Coast	637.0	634.5	627.7
Central Highlands	252.5	245.1	246.8
North East	410.4	403.5	387.5
Mekong River Delta	2 365.2	2 494.6	2 625.1

Source: Tong Cuc Thong Ke 1992: 77–78.

Appendix 12

Production of individual crops ('000 t)

Crop	Production			
	1988	1989	1990	1991
Total	19 583.1	21 515.6	21 488.6	21 717.6
Rice	17 000.0	18 996.3	19 225.1	19 427.6
Spring rice	6 974.1	7 539.3	7 845.8	6 788.3
Autumn rice	3 378.7	4 063.2	4 110.4	4 767.7
Winter rice	6 647.2	7 393.8	7 269.9	7 871.6
Other cereals	2 583.1	2 519.3	2 263.5	2 290.0
Maize	814.8	837.9	671.0	651.6
Root crops and vegetables				
Sweet potato	1 901.8	1 909.2	1 929.0	2 104.5
Cassava	2 839.3	2 585.4	2 275.8	2 389.9
Vegetables	2 909.2	3 135.4	3 204.1	–
Beans	95.0	102.1	106.3	–
Industrial crops — annual				
Cotton	4.2	3.3	2.8	4.9
Jute	36.8	34.3	23.8	26.7
Rushes	83.7	81.2	63.3	49.7
Sugar cane	5 700.4	5 344.6	5 397.7	5 939.8
Peanut	213.9	205.8	213.1	211.7
Soybean	85.3	82.0	86.6	98.7
Tobacco	35.5	23.9	21.8	28.7
Industrial crops — perennial				
Pepper	6.2	7.1	8.6	8.7
Rubber	49.7	50.6	57.9	73.7
Mulberry	–	–	100.0	97.8
Coconut	–	–	894.4	1 038.6
Beverages				
Tea (dry)	29.7	30.2	32.2	–
Coffee (seed)	31.3	40.8	64.1	–
Fruit				
Oranges	–	–	119.2	127.3
Pineapples	–	–	467.9	475.1

Source: General Statistical Office 1992: 114–115.

Appendix 13

Area devoted to various crops ('000 ha)

Crop	Sown area			
	1988	1989	1990	1991
Total	8 883.5	8 978.2	9 040.0	9 326.2
Food crops	6 967.8	7 089.6	7 110.9	7 343.5
Rice	5 726.4	5 895.8	6 027.7	6 295.0
Spring rice	1 882.1	1 992.3	2 073.6	2 159.7
Autumn rice	994.3	1 140.3	1 215.6	1 370.5
Winter rice	2 850.0	2 763.2	2 738.5	2 764.8
Other cereals	1 241.4	1 193.7	1 083.2	1 048.5
Maize	510.5	509.4	431.8	432.9
Root crops and vegetables				
Sweet potato	336.2	327.3	321.1	348.4
Cassava	317.7	284.6	256.8	267.2
Vegetables	242.8	252.0	254.3	–
Beans	158.4	167.4	169.1	–
Industrial crops — annual				
Cotton	12.3	9.2	7.9	–
Jute	17.1	15.7	11.7	10.4
Rushes	17.5	14.4	11.4	–
Sugarcane	142.1	131.3	130.6	141.1
Peanut	224.4	208.6	201.4	196.2
Soybean	103.0	100.2	110.0	115.4
Tobacco	39.5	28.0	26.5	30.8
Industrial crops — perennial				
Pepper	7.6	8.0	9.2	–
Rubber	210.5	215.6	221.7	–
Mulberry	–	–	12.3	12.1
Coconuts	–	–	121.0	134.2
Beverages				
Tea (dry)	59.1	58.3	59.9	–
Coffee (seed)	111.9	123.1	119.3	–
Fruits				
Oranges	–	–	14.5	15.4
Pineapples	–	–	38.9	38.3

Sources: General Statistical Office 1992: 110–111; Statistical Publishing House 1992: 21, 162, 182, 192 and 201.

Appendix 14

Rice production by region ('000 t)

Region	Production		
	1988	1989	1990
Whole country	17 000.0	18 996.3	19 225.2
Northern regions	6 708.7	7 275.4	6 962.4
North Montane & Midland	1 765.9	1 968.6	1 701.9
Red River Delta	3 454.8	3 743.6	3 618.1
Central Coast	1 488.0	1 563.2	1 642.4
Southern regions	10 291.3	11 720.9	12 262.8
Central Coast	1 539.2	1 605.8	1 607.1
Central Highlands	350.4	396.1	386.0
North East	797.3	835.9	789.4
Mekong River Delta	7 604.4	8 883.1	9 480.3

Source: Tong Cuc Thong Ke 1992: 81–82.

Appendix 15

Rice growing areas by region ('000 ha)

Region	Growing area		
	1988	1989	1990
Whole country	5 726.4	5 895.8	6 027.7
Northern regions	2 464.8	2 481.2	2 483.4
North Montane & Midland	745.4	753.1	748.9
Red River Delta	1 050.2	1 057.5	1 057.5
Central Coast	669.2	670.6	677.0
Southern regions	3 261.6	3 414.6	3 544.3
Central Coast	486.6	496.2	494.9
Central Highlands	159.3	160.8	165.3
North East	301.9	312.8	304.0
Mekong River Delta	2 313.8	2 444.8	2 580.1

Source: Tong Cuc Thong Ke 1992: 83.

Appendix 16

Maize production by region ('000 t)

Region	Production			
	1985	1988	1989	1990
Whole country	587.1	814.8	837.9	671.0
Northern regions	318.5	582.5	597.6	452.9
North Montane & Midland	216.0	271.1	301.7	246.5
Red River Delta	61.4	226.6	231.8	148.1
Central Coast	41.1	84.8	64.1	58.3
Southern regions	208.6	232.3	240.3	218.1
Central Coast	33.9	26.5	31.1	29.3
Central Highlands	100.8	90.6	96.5	91.5
North East	114.8	82.1	80.5	71.7
Mekong River Delta	19.1	33.1	32.2	25.6

Source: Tong Cuc Thong Ke 1992: 104–105.

Appendix 17

Maize growing area by region ('000 ha)

Region	Growing area			
	1985	1988	1989	1990
Whole country	397.3	510.5	509.4	431.8
Northern regions	241.2	366.7	369.0	298.0
North Montane & Midland	169.2	198.9	202.6	183.8
Red River Delta	33.7	110.5	112.9	69.3
Central Coast	38.3	57.3	53.5	44.9
Southern regions	156.1	143.8	140.4	133.7
Central Coast	34.1	29.1	28.6	28.2
Central Highlands	53.5	48.8	48.7	45.9
North East	57.0	50.7	49.4	48.5
Mekong River Delta	11.5	15.2	13.7	11.1

Source: Tong Cuc Thong Ke 1992: 106–107.

Appendix 18

Cassava production by region ('000 t)

Region	Production			
	1985	1988	1989	1990
Whole country	2 939.8	2 839.3	2 585.4	2 275.8
Northern regions	1 449.7	1 393.3	1 378.5	1 180.4
North Montane & Midland	887.1	921.6	892.2	748.8
Red River Delta	158.5	164.8	165.1	139.4
Central Coast	404.1	306.9	321.2	292.2
Southern regions	1 490.1	1 446.0	1 206.9	1 095.4
Central Coast	641.4	521.4	520.4	507.9
Central Highlands	197.2	252.9	215.9	204.9
North East	531.5	560.6	356.0	281.1
Mekong River Delta	120.0	111.1	114.6	101.5

Source: Tong Cuc Thong Ke 1992: 116–117.

Appendix 19

Cassava growing areas by region ('000 ha)

Region	Growing area			
	1985	1988	1989	1990
Whole country	335.0	317.7	284.6	256.8
Northern regions	176.8	163.1	158.6	140.8
North Montane & Midland	89.5	90.6	89.4	78.7
Red River Delta	23.7	23.1	22.9	19.3
Central Coast	63.6	49.4	46.3	42.8
Southern regions	158.2	154.6	126.0	116.0
Central Coast	71.9	67.7	60.5	59.3
Central Highlands	21.1	28.0	22.6	21.1
North East	50.4	45.7	29.7	23.4
Mekong River Delta	14.8	13.2	13.2	12.1

Source: Tong Cuc Thong Ke 1992: 118–119.

Appendix 20

Sweet potato production by region ('000 t)

Region	Production			
	1985	1988	1989	1990
Whole country	1 777.7	1 901.8	1 909.2	1 929.0
Northern regions	1 089.5	1 327.7	1 374.9	1 404.4
North Montane & Midland	186.7	276.8	345.5	347.0
Red River Delta	291.8	402.9	418.4	486.3
Central Coast	567.0	648.0	611.0	571.1
Southern regions	688.2	574.1	534.3	524.6
Central Coast	320.9	229.2	203.6	193.3
Central Highlands	121.2	102.3	85.4	95.0
North East	50.4	43.9	40.0	43.7
Mekong River Delta	195.7	198.7	205.3	192.6

Source: Tong Cuc Thong Ke 1992: 110–111.

Appendix 21

Sweet potato growing areas by region ('000 ha)

Region	Growing area			
	1985	1988	1989	1990
Whole country	320.0	336.2	327.3	321.1
Northern regions	208.5	242.0	243.4	239.8
North Montane & Midland	45.7	53.4	54.6	58.8
Red River Delta	47.5	64.0	59.8	63.1
Central Coast	115.4	124.6	129.0	117.9
Southern regions	111.5	94.2	83.9	81.3
Central Coast	63.3	49.2	43.8	40.6
Central Highlands	19.1	15.4	11.5	13.4
North East	9.7	8.7	7.8	7.9
Mekong River Delta	19.4	20.9	20.8	19.4

Source: Tong Cuc Thong Ke 1992: 112–113.

Appendix 22

Peanut production ('000 t) and growing areas ('000 ha) by region

Region	Production		Growing areas	
	1989	1990	1989	1990
Whole country	205.8	213.1	208.6	201.4
Northern regions	93.4	93.0	103.8	95.7
North Montane & Midland	30.1	25.0	35.3	30.3
Red River Delta	22.0	22.0	22.3	21.1
Central Coast	41.3	46.0	46.2	44.3
Southern regions	112.4	120.1	104.8	105.7
Central Coast	17.4	17.4	21.2	21.9
Central Highlands	16.1	17.5	18.6	20.5
North East	59.7	62.3	51.8	50.3
Mekong River Delta	19.2	22.9	13.2	13.0

Source: Tong Cuc Thong Ke 1992: 132–133.

Appendix 23

Coconut production by region ('000 t)

Region	Production		
	1985	1990	1991
Whole country	611.8	894.4	1038.6
Northern regions	16.7	23.8	26.7
North Montane & Midland	–	–	–
Red River Delta	–	–	–
Central Coast	12.4	20.7	23.6
Southern regions	595.0	870.6	1011.9
Central Coast	92.1	113.1	134.7
Central Highlands	–	–	–
North East	16.1	100.9	109.0
Mekong River Delta	486.9	654.8	766.9

Source: Statistical Publishing House 1992: 186–187.

Appendix 24

Coconut growing areas by region ('000 ha)

Region	Growing areas		
	1985	1990	1991
Whole country	80.7	121.0	134.2
Northern regions	2.7	2.5	2.6
North Montane & Midland	–	–	–
Red River Delta	–	–	–
Central Coast	2.1	2.0	2.1
Southern regions	78.0	118.5	131.6
Central Coast	8.6	12.1	16.9
Central Highlands	–	–	–
North East	1.2	7.9	9.0
Mekong River Delta	68.2	98.2	105.5

Source: Statistical Publishing House 1992: 182–183.

Appendix 25

Sugarcane production ('000 t) and growing areas ('000 ha) by region

Region	Production		Growing areas	
	1989	1990	1989	1990
Whole country	5 344.6	5 397.6	131.3	130.6
Northern regions	726.4	699.0	20.9	19.9
North Montane & Midland	285.2	255.9	9.4	8.4
Red River Delta	189.6	175.1	4.3	4.3
Central Coast	251.6	268.0	7.2	7.2
Southern regions	4 618.2	4 698.6	110.4	110.7
Central Coast	806.1	864.4	23.4	24.5
Central Highlands	237.1	213.3	7.5	6.7
North East	1 085.9	1 112.1	26.7	26.8
Mekong River Delta	2 489.1	2 508.8	52.8	52.7

Source: Tong Cuc Thong Ke 1992: 130–131.

Appendix 26

Orange production by region ('000 t)

Region	Production			
	1980	1985	1990	1991
Whole country	83.3	111.3	119.2	127.3
Northern regions	24.0	31.8	36.2	44.7
North Montane & Midland	3.5	8.6	11.3	12.0
Red River Delta	11.2	10.6	17.9	20.0
Central Coast	9.3	12.5	6.9	12.6
Southern regions	59.2	79.4	83.1	82.6
Central Coast	–	–	–	–
Central Highlands	–	–	–	–
North East	–	–	–	–
Mekong River Delta	58.6	74.1	79.0	78.8

Source: Statistical Publishing House 1992: 199–200.

Appendix 27

Orange growing areas by region ('000 ha)

Region	Growing areas			
	1980	1985	1990	1991
Whole country	12.1	14.0	14.5	15.4
Northern regions	6.0	6.7	6.5	7.5
North Montane & Midland	1.4	1.7	2.2	2.3
Red River Delta	1.8	1.7	1.7	1.9
Central Coast	2.8	3.3	2.6	3.3
Southern regions	6.0	7.3	8.0	7.9
Central Coast	–	–	–	–
Central Highlands	–	–	–	–
North East	–	–	–	–
Mekong River Delta	5.8	6.8	7.5	7.4

Source: Statistical Publishing House 1992: 192–194.

Appendix 28

Postharvest pests and diseases in tropical countries

Rice

Fungi

Grain fungi can be divided into field fungi and storage fungi.

Alternaria, *Helminthosporium*, *Cladosporium* and *Fusarium* which required moisture contents of 20 to 25% are problems in the field but do not proliferate in dry conditions.

Storage fungi such as *Aspergillus* and *Penicillium* species may develop on grain with 12–18% moisture contents. *Aspergillus flavus* grows on inadequately dried cereals and oilseeds. It causes deterioration of proteins, starch and oils. Some strains may produce aflatoxins which are extremely carcinogenic in humans. *Aspergillus niger* grows under similar conditions as *A. flavus* but the toxin produced is not as dangerous to man as aflatoxin. *Aspergillus glaucus* is a very common mould and can grow on substrates with low moisture and high sugar content.

Insects

Sitophilus spp. (Col. Curculionidae) (grain weevil) is the most common and most important pest in tropical farm storage. It attacks rice, maize, sorghum and wheat. The weevil is identified by its dark brown colour, sometimes with four lighter spots on the wing, and its elongated snout. It is 2–4.0 mm in length. *Sitophilus oryzae* (rice weevil) is common in rice and *Sitophilus zeamais* (maize weevil) is common in maize. They are found in Bac-Thai, Cao-Bang, Ha-Bac, Ha-Giang, Ha-Noi, Ha-Tay, Lang-Son, Nam-Ha, Nghe-An, Quang-Ninh and Thai-Binh. Crops subject to infestation include rice, peanuts, mung beans, soya beans, maize, sesame and tobacco.

Rhizopertha dominica (Col. Bostrychidae) (lesser grain borer) infests paddy rice, milled rice, and also infests maize, sorghum and cassava. This borer is identified by its dark-brown cylindrical body. Its size is about 2.5 to 3.0 mm in length. It occurs in Nghe-An.

Tribolium castaneum (Col. Tenebrionidae) (red flour beetle) is most commonly found in milled rice but may attack any cereal product. It is identified by its reddish-brown, slightly flattened body and has a length of 2.0–4.5 mm. It is prevalent in Bac-Thai.

Oryzaephilus spp. (Col. Silvanidae) (merchant and saw-tooth grain beetle) infest milled cereals, especially rice, and oil-seeds. They are identified by their reddish-brown, flattened body, long antennae, and are usually 1.5–2.0 mm long.

Trogoderma granarium (Col. Dermestidae) (khapra beetle) infests cereals, groundnuts, grain legumes, and is a major pest in dry products. Larvae can enter a resistant resting phase which can last for several years, making it difficult to eradicate. This species can be identified by its dark brown body and very fine hair. It is about 3 mm long.

Cryptolestes spp. (Col. Cucujidae) (flat grain beetle) infests milled cereals, cowpea and cocoa. It can be identified by its red-brown colour and flattened small body which is 1–2 mm long.

Sitotroga cerealella (Lep. Gelechiidae) (Angoumois grain moth) attacks the surface of paddy rice, maize, sorghum, wheat and other cereals. This moth is identified by its yellow-brown forewings and pointed hind-wings. It has a wingspan of about 12 mm.

Ephestia corcyra (rice moth). Caterpillars of this moth produce silk which binds rice grain together into a lump.

Ephestia cautella, Walk (Lep. Pyralidae)(tropical warehouse moth). This moth is identified by its forewings which are grey with a dark band across the middle and far edge. It has a wingspan of about 15 mm.

Rodents

Microtus arvalis Pall. (field mouse). These pests can multiply very rapidly. One pair of field mice is capable of producing 6 litters per year. A litter usually consists of 8 young. After about 90 days, the young mice are mature and can reproduce.

Mus musculus L. (House mouse). May cause severe damage to stocks of foods and other commodities.

Rattus rattus L. (Black rat) and *Rattus norvegicus* Berkenh (brown rat, Norway rat). Of these two rat species, the brown rat is the more abundant.

Maize

Fusarium species is a widely occurring fungus associated with storage rots. It is a pathogen which causes blight and blast in cereals and sugar cane. It can survive in the seed and continue to grow during storage. Some species produce toxins in stored maize which are hazardous to human health.

Ustilago zeae (Beckm.) Ung. fungus (common smut of corn) is a whitish-grey tumour which grows on mature corn and covers the corn ears with a dark smut. The tumour contains black dust which consists of microscopically small spores of the fungus. When the tumour bursts, the spores are transported by the wind and infect other plants.

Pyrausta nubilalis Hb (European corn borer, corn moth). Caterpillars feed on corn leaves, then bore into the stalk and travel to the centre of the corn, severely damaging the corn.

Sitophilus zeamais (maize weevils), see under rice insects.

Angoumois grain moth, see under rice insects.

Potato

Phytophthora infestans (Mont.) de Bary fungus (potato blight, late blight): blight is the most important fungus disease of potatoes. Blight causes destruction of the foliage and also losses occur in storage. Infected tubers also introduce secondary infections of various fungi.

Rhizoctonia solani K. (black speck, stem cander, collar rot, black scurf, damping off). The damage caused by early-season infection is responsible for the heaviest losses which may amount to 50% of the total crop.

Vegetables

Pythium irregular (Buis.) (brown rot) causes brownish discolouration of the tuber tissue of sugar beet.

Colletotrichum lindemuthianum (Sacc. et Magn.) Bri. et Cav. (bean anthracnose) infests bean pods and bean seed.

Ascochyta pisi (Lib.) (ascochyta blight) infests peas.

Phytophthora infestant de Bary. fungus (tomato blight, late blight). Damage to the fruit can cause considerable losses both before and during harvesting, but in warm wet seasons the bulk of the crop may be destroyed before ripening.

Semiaphis dauci F. (Carrot aphid) causes severe stunting in carrots, often death and very poor yield.

Psila rosae F. (carrot rust fly, carrot fly). The maggots are the larvae of the carrot rust fly. Carrot fly is one of the most important pests of carrots, it reduces both yield and quality.

Oranges

Penicillium species is commonly associated with fruit rots. The mycelium is bluish-green and may be aerial or embedded in the substrate. It is widely dispersed.

Botryodiplodia species attack fruits or seeds in the field and deterioration continues in storage. The mycelium is black in *B. theobromae*; spores are produced in enclosed pycnidia (cavities) at the surface of the substrate.

Mucor pusillus is a fungus associated with spoilage and decay. It is strongly thermophilic, for example it can survive the high temperatures of fermenting cocoa.

Tetranychidae (spider mites) rank among the most serious pests of citrus fruits, the infested fruits lose much of their market value due to malformation and discolouration.

Icerya purchasi Mask (cottony cushion scale, citrus fluted scale, Australian bug) is a native of Australia, and it was introduced into California in 1968. Today this polyphagous pest occurs in nearly all citrus-growing regions of the world.

Diaspididae (armoured scales) are not easy to remove from the fruit by washing, therefore the market value of infested fruits is considerably lowered.

Sugarcane

Pseudococcus sacchari Ckll (sugarcane mealy bug, pink mealy bug). Leaves and stalks are contaminated by honeydew and sooty mould. Red discolouration appears on leaf sheaths, usually close to the nodes. Lowering of cane vitality results in a reduction of plant resistance especially to fungal infections.

Rhopalosiphon sacchari Zehnt (sugarcane aphid). The damage caused by the insects feeding is not as great a problem as the fact that aphids act as virus vectors for sugarcane. This insect is prevalent in Ha-Noi and Ha-Tay.

Physalospora tucumanensis Speg. fungus (red rot, red smut). The inside of sugarcane turns pink or black. When the fungus has been established on the plant for some time, the midribs of the leaves often turn red, too. Eventually, the plant becomes muddy, shrinks and dies.

Peanuts

Callosobruchus maculatus (bean weevil) (Col. Bruchidae). Rather big beetles, active with long legs and antennae, feed on cowpeas, pigeon peas; *Caryedon serratus* feed on groundnuts; *Acanthoscelides* feed on beans. This weevil is prevalent in Ha-Giang and Lang-Son. It infests rice, beans and peanuts.

Tea

Exobasidium vexans (Massee) fungus (blister blight) causes tea quality to decline.

Homona coffearia Nietn. (tea tortrix, sandwich caterpillar, flush worm). This pest is widespread in most tea and coffee growing regions of South and East Asia. It is found in Ha-Tay and Hoa-Binh.

Helopeltis spp. (tea mosquito bug) causes light-brown, sunken, translucent spots on young tea leaves.

Coffee

Stephanoderes hampei Ferr. (coffee cherry borer) bores holes in coffee cherry.

Cercospora coffeicola Berk. et Cke. fungus (brown eye spot, brown leaf spot, Cercospora blotch). Infections in seed beds are often very serious.

Araeocerus fasciculatus (coffee-bean weevil) (Col. Anthribidae) is grey-brown, usually slightly mottled, similar in shape to a bruchid. Feeds on coffee, cocoa and cereals. It is found in Bac-Thai, Ha-Tay and Nghia-Lo.

Further references

FAO Training Series 1985: 17–27; Sinclair and White 1992: 2–3; Duong et al. 1978; Vien Bao Ve Thuc Vat 1969; and Bayer Pflanzenschutz Compendium 1968.

Appendix 29

Production of livestock and poultry ('000 head)

	1980	1985	1990	1991
Buffalo	2 313.0	2 590.2	2 854.1	2 885.6
Cattle	1 664.2	2 597.6	3 116.6	3 151.0
Pigs	10 001.2	11 807.5	12 260.5	12 140.4
Horses	115.6	132.7	141.3	–
Poultry	64.5	91.2	107.4	108.2

Source: Tran Hoang-Kim 1992: 138.

Appendix 30

Animal production ('000 t liveweight)

	1980	1985	1990	1991
Total	456	747	886	1150
Beef	65	65	78	90
Pork	292	561	652	800
Poultry	99	121	156	260

Source: Industrial Development Review Series 1991: 69.

Appendix 31

Animal breeding by region (million head of livestock)

Region	Buffalo		Cattle		Pigs	
	1989	1990	1989	1990	1989	1990
Whole country	2.87	2.85	3.20	3.12	12.22	12.26
Northern regions	2.17	2.21	1.45	1.45	7.81	8.02
North Montane & Midland	1.25	1.29	0.54	0.52	2.99	3.09
Red River Delta	0.36	0.36	0.28	0.29	2.81	2.88
Central Coast	0.56	0.57	0.64	0.64	2.02	2.05
Southern regions	0.70	0.64	1.75	1.66	4.40	4.24
Central Coast	0.15	0.15	0.88	0.85	1.40	1.34
Central Highlands	0.06	0.06	0.34	0.34	0.58	0.58
North East	0.15	0.14	0.23	0.22	0.59	0.52
Mekong River Delta	0.33	0.29	0.29	0.26	1.84	1.81

Source: Tong Cuc Thong Ke 1992: 140–141.

Appendix 32

Fisheries production and export ('000 t)

	1981	1985	1988	1990
Total production	600	780	876	980
Marine fishery	420	550	622	670
Inland fishery	180	230	254	307
Export value (US$ million)	20	90	167	205

Source: Ministry of Fisheries & UNDP 1992: 29.

Appendix 33

Fishing vessels and their capacity by region

Region	Number of vessels			Capacity ('000HP)		
	1985	1988	1990	1985	1988	1990
Whole country	29 260	43 860	41 200	485	590	720
Northern regions	660	1 114	1 640	53	56	55
North Montane & Midland	150	415	930	10	14	12
Red River Delta	510	700	710	43	41	43
Central Coast	3 155	5 780	7 730	60	87	104
Southern regions	25 440	36 960	31 820	370	445	560
Central Coast	14 050	16 400	16 690	168	206	243
Central Highlands						
North East	2 510	2 460	3 810	73	72	110
Mekong Delta	8 880	18 100	11 320	130	170	210

Source: Ministry of Fisheries & UNDP 1992: 30.

Appendix 34

Potential areas for aquaculture by region

Region	Total	Pond	Paddy field	Reservoir	Tidal flat	Lagoon bays
	('000 ha)	area (%)				
Whole country	1 380	58	548	398	291	85
Northern regions	435	49	52	200	92	42
North Montane & Midland	188	15	15	94	44	20
Red River Delta	145	30	31	51	34	–
Central Coast	102	4	6	55	14	22
Southern regions	945	9	496	197	199	43
Central Coast	120	–	–	55	22	43
Central Highlands	65	–	–	65	–	–
North East	140	1	12	78	50	–
Mekong Delta	620	8	484	–	127	–

Source: Ministry of Fisheries & UNDP 1992: 31.

Appendix 35

Agricultural processing industries

Enterprises		Capacities (t/year)		
Type	Number	Installed	Utilised	Maximum practical
Rice milling	963	2 378 000	–	–
Meat processing	10	50 000	20 000	40 000
Feather	–	2 000	1 500	1 500
Fruit/vegetables	13	45 000	32 000	41 000
Freezing/cooling plants	6	20 000	17 000	20 000
Drying	50	6 000	4 000	5 000
Sugar factories	10	11 000	5 500	8 800
Glucose	1	2 000	1 400	2 000
Alcohol	3	23	18	22
Beer	2	140	85	105
Other beverages	1	50	16	30
Confectionery	1	21 000	12 500	17 500
Coconut oil	–	50 000	22 000	40 000
Peanut oil	–	5 000	4 000	5 000
Coffee	–	300	70	300
Milk	2	175	45	70
Monosodium glutamate	–	3 000	2 200	2 500
Animal Feed	–	480 000	240 000	420 000
Silkworm	–	180	100	135
Jute	–	160	90	120
Cotton	–	5 000	1 000	3 000

– = data not available
Source: UNDP 1991: 52.

Appendix 36

Estimated output of agricultural processing industries ('000 t/year)

	Total output	State-owned	Private owned	Unprocessed
Rice (paddy)	16 600	3 437	5 265	7 898
Sugar cane	5 535	2 227	3 309	–
Cassava	2 790	–	558	2 232
Animal feed	> 240	> 240	–	–
Fish sauce	> 100	–	> 100	–
Frozen fish	27	27	–	–
Dried fish	16	16	–	–
Fish meal	7	7	–	–
Canned fish	1	1	–	–
Slaughtered meat	129	129	–	–
Frozen meat	11	11	–	–
Sausage meat	1	1	–	–
Canned meat	2	2	–	–
Beer	98	98	–	–
Spirits	17	17	–	–
Ethanol	13	13	–	–
Jute	56	–	–	–
Silk	1	1	–	–
Cotton	< 1	< 1	–	–
Vegetable oil	65	30	35	–
Rubber	50	–	–	–
Pineapples	> 427	31	–	396
Bananas	1 151	5	–	1 146
Oranges	105	12	–	93
Condensed milk	52	52	–	–
Coffee	50	20	30	–
Baked products	30	–	–	–
Biscuits	26	3	23	–
Confectionery	36	3	33	–
Tea (dried)	28	28	–	–
Wheat (imported)	30	30	–	–
Instant noodles	–	18	–	–
Weaning foods	4	4	–	–
Glutamate	2	2	–	–
Total	27 698	6 464	9 444	11 765

– = data not available

Source: UNDP 1991: 50.

Appendix 37

Agricultural exports by product

Products	Quantity exported ('000 t)				
	1985	1988	1989	1990	1991
Rice	59.4	91.2	1 420.2	1 624.0	1 000.0
Rubber	35.2	38.0	57.7	75.9	60.0
Jute	10.1	17.7	4.9	12.4	–
Peanut	64.1	154.4	79.6	155.8	150.0
Tea	10.4	14.8	15.0	16.1	10.0
Coffee	9.2	33.8	57.4	89.6	
Coconut oil	–	–	–	19.3	12.0
Canned fruit	19.4	24.8	23.0	24.2	–
Bananas	11.7	6.9	3.3	2.9	–
Pineapples	3.5	0.2	1.9	–	
Seafood	10.3	31.2	42.9	45.7	–
Frozen meat	–	–	7.7	16.2	–
Products	Value of exports (U.S.$ million)				
Rattan & bamboo produce	31.7	36.5	54.4	44.0	–
Jute carpet	8.0	10.3	14.3	19.1	–
Jute fibre	–	–	2.4	2.1	1.0
Rushes	20.6	35.3	41.6	12.1	–

– = not applicable or data not available

Sources: General Statistical Office 1992: 236–237; Tong Cuc Thong Ke 1992: 214.

Appendix 38

Exports by destination

Commodity	1987	1988	1989	1990
Rice (' 000 t)	120.5	105.0	1 425.2	1 624.4
USSR	–	–	–	146.8
Albania	1.0	2.0	5.8	4.5
Cuba	2.0	7.0	14.1	10.7
France	108.4	75.0	324.6	161.6
Indonesia	–	–	131.2	–
Hong Kong	0.8	0.6	99.2	7.9
India	–	–	61.1	44.9
Iran	–	–	–	94.6
Japan	–	–	–	15.0
Philippines	–	–	–	334.8
Peanuts (t)	132 346	153 992	76 690	155 823
USSR	46 008	23 244	10 076	6 040
Bulgaria	5 996	–	962	474
GDR	–	472	–	–
Hungary	2 240	3 228	–	–
Czechoslovakia	6 316	6 560	–	–
Albania	2 000	–	–	–
Hong Kong	–	–	–	17 278
France	–	–	–	1 504
Singapore	–	–	–	35 500
GFR	–	–	–	2 046
Coconut oil (t)	13 090	8 531	19 341	12 004
USSR	7 953	5 013	17 156	9 153
Romania	–	481	200	300
GDR	–	–	–	485
Hungary	–	294	–	–
India	1 472	1 472	–	–
Japan	1 464	–	–	–
France	457	–	–	–
Australia	18	–	–	–
Coffee (t)	25 825	33 803	56 901	89 583
USSR	5 086	6 027	10 949	234
GDR	892	1 398	2 445	1 602
Hungary	480	450	450	450
Romania	100	150	150	200
Bulgaria	800	1 200	500	2 219
Poland	400	1 450	1 950	200
Czechoslovakia	500	500	550	400
Albania	450	150	1 000	1 071
Laos	580	91	–	–
Hong Kong	300	36	1 790	4 126

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Appendix 38 — cont'd

Commodity	1987	1988	1989	1990
Coffee — cont'd				
France	2 307	3 667	2 607	6 200
Singapore	8 703	9 283	6 233	17 631
United Kingdom	–	–	381	–
Japan	75	–	–	300
Algeria	–	800	–	1 000
Tea (t)	11 874	14 849	15 012	16 076
USSR	6 228	7 694	9 075	10 704
Bulgaria	488	377	–	–
Cuba	267	226	209	140
GDR	623	494	545	63
Hungary	327	534	197	203
Romania	299	316	106	–
Czechoslovakia	248	195	680	1 139
India	–	157	–	–
Albania	15	9	14	10
Poland	1 078	1 339	722	200
Hong Kong	935	1 898	1 084	588
Singapore	264	548	1 465	561
Iraq	708	919	352	621
Algeria	–	–	238	501
United Kingdom	–	–	304	1 051
Canned fruit (t)	19 262	25 126	22 681	24 200
USSR	15 463	17 393	15 344	17 480
Poland	785	773	1 326	119
Bulgaria	897	1 494	1 003	947
GDR	474	824	1 002	170
Hungary	418	889	664	2 326
Mongolia	225	112	88	180
Romania	–	109	60	49
Czechoslovakia	977	3 520	3 105	2 710
Netherlands	17	12	89	12
Processed meat (t)	8 922	4 800	7 743	16 155
USSR	8 159	4 250	7 743	14 828
Bulgaria	763	550	–	503
Frozen prawns (t)	21 098	28 268	–	37 635
Japan	6 386	8 079	–	11 368
Hong Kong	4 987	8 361	1 332	3 688
Singapore	461	1 186	18	1 435
Australia	663	280	–	126
France	415	297	–	167
United Kingdom	–	60	–	–
Italy	57	–	–	–
Belgium	59	48	–	10
Canada	122	–	–	54
Other countries	7 948	9 957	–	–

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Appendix 38 — cont'd

Commodity	1987	1988	1989	1990
Cinnamon (t)	1 845	1 386	2 444	2 097
USSR	501	500	500	700
Bulgaria	40	40	40	63
Poland	32	30	30	–
Cuba	30	30	60	29
GDR	15	25	25	25
Hungary	100	50	188	363
Romania	8	28	15	53
Czechoslovakia	20	20	17	33
KDR	10	32	45	–
Albania	3	3	3	3
Hong Kong	466	286	411	317
Iraq	125	150	272	–
Japan	167	191	284	106
Singapore	73	1	2	40
Algeria	–	–	–	200
Others	255	0.2	552	–
Rubber (t)	37 584	38 015	57 703	78 875
USSR	27 000	28 289	31 715	30 000
Bulgaria	195	961	144	300
Poland	720	1 070	1 530	–
Cuba	1 000	1 000	1 000	800
GDR	600	350	750	–
Hungary	900	700	550	–
KDR	300	–	300	–
Czechoslovakia	750	340	1 210	–
Romania	–	200	200	200
Albany	250	850	300	200
Singapore	3 734	4 185	13 546	15 250
Hong Kong	–	70	54	10
China	–	–	–	230

– = not applicable or data not available

Source: Tran Hoang-Kim 1992: 186–192.

Appendix 39

International cooperation

Funding from UNDP, FAO acts as an executing agency

Project no.	Period	Title
VIE80004J01	1983–89	Maize research and development.
VIE80005N01	1983–88	Horticulture: research, development and training.
VIE80007K01	1982–88	Training in rubber development.
VIE80008101	1984–89	Coffee rehabitation and improvement.
VIE80009101	1983–88	Development of the coconut industry.
VIE80010		Seed production.
VIE80011J01	1983–88	Sericulture.
VIE80012P01	1981–88	Veterinary research and vaccine production.
VIE80013G01	1985–90	Milk production.
VIE80014M01	1981–88	Postharvest protection of agricultural food products.
VIE82001001	1983–88	Development of agricultural research.
VIE82009N01	1983–88	Strengthening plant protection services
VIE83002F01	1986–89	Nghia-Binh shrimps.
VIE83004k01	1984–88	Utilisation of remote-sensing data for assessing agricultural resources.
VIE84001G01	1985–88	Cotton improvement and extension.
VIE85005H01	1988–94	Cashew nut development.
VIE85011D01	1986–89	Mushroom production.
VIE85016E01	1987–89	Vegetable production.
VIE86006D01	1987–88	Veterinary health services.
VIE86001		Water management in Thai-Binh.
VIE86002		Seed certification.
VIE86003		Improved supply and distribution of fertilizer.
VIE86005		Citrus and lychee production.
VIE86007B01	1987	Strengthening of the duck research and multiplication centre in Dye-Xuyen.
VIE86008A01	1987	Beef cattle development.
VIE86009		Chicken development.
VIE86010A01	1987	Modernisation of the experimental seaweed cultivation centre.
VIE86011A01	1987	Fresh-water fish culture.
VIE86024C01	1987	Agricultural planning and protection.
VIE86003A01	1987	Improvement of supply and distribution of fertilizer.
VIE87027A01	1988–90	Seed production.
VIE88016		Marine products fishing technology.
VIE88033		Agricultural and food production review.

Funding from UNDP, UNIDO acts as an executing agency

DPVIE80032		Pilot production of medicines using indigenous raw materials.
DPVIE80033	1985–89	Assistance to the food canning industry
DPVIE80037	1981–88	Rehabitation of sugar mills, including progressive local manufacture of spare parts and sugar mill equipment.
DPVIE80040	1981–89	Production of bakers' yeast in Ha-Noi.
DPVIE81006	1982–87	National network of standardisation, metrology, quality testing and calibration services.
DPVIE82004	1984–89	Repair and maintenance centre and spare parts production for rice mills.
DPVIE83001	1984–88	National Centre of Metrology.
DPVIE84002	1984–88	Institute for Tropical Technology and Environmental Protection.
DPVIE84010	1985–91	Development of industrial production of essential oils, aromas and flavours.
DPVIE85009	1987–88	Assistance to maintenance and repair centre for testing and measuring equipment (CMR).

Appendix 39 — cont'd

Project no.	Period	Title
DPVIE85012	1987–89	Development of plastic industry.
DPVIE85013	1986–87	Assistance to the Leather Industry Research Centre, Ha-Noi.
DPVIE86013	1988–90	Assistance to the Food Industries Research Institute (FIRI).
DPVIE86016		Pharmaceuticals from animal by-products.
DPVIE86033		Processing of aroma chemicals and fragrance materials.
DPVIE86046		Packaging Technology and Development Centre.
DPVIE87001		Strengthening the Mechanical and Electrical Refrigeration Centre.
DPVIE87002		Canning and quality control of marine products.
DPVIE87009	1988–89	Strengthening quality control and testing facilities of non-alcoholic liquid foods including fish sauce and soybean sauce.
DPVIE87011		Quality improvement of rubber products.
Funding from UNDP, UNESCO acts as an executing agency		
VIE80052	1983–88	Assistance for upgrading of Faculty of Biology and Agronomy, Ha-Noi.
VIE80050	1983–88	New methods in chemical analysis.
Funding from UNDP, ITC acts as an executing agency		
VIE0057	1987	Establishment of a trade information service (TIS).
VIE2008	1987	Quality control and pre-shipment inspection of export products.
VIE4009	1987	Development of export packaging (preparatory assistance).
Funding from UNICEF		
UNICEFSVNN002S	1987–91	Nutrition.
UNICEFSVNN007G	1978–91	Nutrition.
UNICEFSVNN011S	1987–91	Household food security (VAC).
UNICEFSVNN014S	1987–91	Nutrition VAC system.
Others		
VIE5011	1987–89	Isotope techniques in soil–plant studies.
D69613	1985–90	Development of water resources in Binh-Tri-Thien provinces.

Funding from other international organisations

- ABARE (Australian Bureau of Agricultural and Resource Economics).
- AIDAB (Australian International Development Assistance Bureau).
- All Union Institute of Plant Production, Leningrad, USSR.
- Asian Vegetables Research and Development Centre.
- Asian Centre of CIP (Centro Internacional de la Papa) Los Baños, Philippines.
- AVRDC/ TOP (Thailand Outreach Programs), Kasetsart, Thailand.
- CIAT (Centro Internacional de Agricultura Tropical), Cali, Colombo.
- CIRCA (Cambridge International Reference on Current Affairs).
- CIMMYT (Centro Internacional de Meijoramiento de Maiz y Trigo), Mexico city, Mexico.
- CIP (International Potato Centre).
- ESCAP.CGPRT Centre: Regional Co-ordination Centre for Research and Development of Coarse, Pulse, Root and Tuber Crops in the Humid Tropics of Asia and the Pacific.
- FCD/ FOS (Fonds de Cooperation pour Development), Belgique.
- HEKS (Hilfswerk der Evangelische Kirches der Schweiz), Berne, Suisse.
- IAEA (International Atomic Energy Agency), Vienna, Austria.
- IDRC (International Development Research Centre), Canada.
- IIRR (International Institute of Rural Reconstruction), Philippines.

Appendix 39 — cont'd

Project no.	Period	Title

- INRA (Institut National de Recherche Agronomique), Paris, France.
- International Committee for Co-ordination of Investigations of the Lower Mekong Delta Basin.
- IRAT/ CIRAD (Institut de Recherches Agronomiques Tropicales), Montpellier, France.
- IRRI (International Rice Research Institute), Los Baños, Philippines.
- ORSTOM, France: Nematode diseases in crops in the Mekong Delta.
- Swedish Agency for Research Cooperation with Developing Countries.
- Tropical and Subtropical Agricultural Research Institute, Prague, Czechoslovakia.
- Winrock International Institute for Agricultural Development.

Funding from non-government organisations (NGO)

- AAACU (Asian Association of Agricultural Colleges and Universities).
- Adventist Development and Relief Agency.
- AIT (Asian Institute of Technology).
- SUAN (South East Asian Universities Agro-ecosystem Network).
- Bread for the World, The Federal Republic of Germany.
- Church World Service, USA.
- Committee on Science and Technology for Vietnam.
- Cooperative Services International, USA.
- Cooperative Internationale pour le Development et la Solidarite.
- Heifer Project International, USA
- Mennonite Central Committee, USA and Canada.
- Oxfam America, USA.
- SAREC, Sweden.
- Terre des Hommes, The Federal Republic of Germany.
- The Dutch Committee on Technical Cooperation with Vietnam, The Netherlands.
- U.S. Committee for Scientific Cooperation with Vietnam, USA:
- World Vision International.

Funding from overseas universities

- Agricultural Institute of Gembloux, Belgium.
- Agricultural University in Kuban, USSR.
- Asian Institute of Technology (AIT), Bangkok, Thailand.
- Catholic University Louvain La Neuve, Belgium.
- Chiang Mai University, Thailand.
- CIRAD (Centre d'Information et de Documentation en Agronomie des Regions Chaudes), France.
- CLSU (Central Luzon State University), Philippines.
- CTFT (Centre Technique Forestier Tropical), France.
- East–West Centre, Hawaii, USA.
- Ecole Nationale Veterinaire Maisons Alfort, France.
- EIB/ACCT (Ecole Internationale de Bordeaux), Bordeaux,
- Godollo University of Agricultural Sciences, Hungary.
- INA (Institut National Agronomique), Paris-Crignon France.
- Karl Marx Universitat Leipzig, Federal Republic of Germany.
- Kasetsart University, Thailand.
- Kasetsart Agriculture University, Thailand.
- Khon Kean University, Thailand.
- Louvaine-la-Neuve Catholic University, The Netherlands.
- Michigan State University, USA.
- Odessa Medical University, USSR.
- Odessa State University, USSR.
- Olstyn Agricultural Sciences Institute, Poland.
- SUAN (South East Asian Universities Agro-ecosystem Network).

Appendix 39 — cont'd

Project no.	Period	Title

- Swedish University of Agricultural Sciences.
- UCL (Universite Catholique de Louvain), Belgique.
- University Lyon I, INRA, Wageningen Agricultural University, France and Netherlands.
- University Lyon I, INRA, CNRS Museum National, Paris France.
- University of Agriculture in Brno, Czechoslovakia.
- University Paris-Sud, Centre d'Orsay, France.
- University of Hawaii, Manoa, USA.
- University of Wisconsin, Madison, USA.
- UPLB (University of the Philippines at Los Baños), Philippines.
- Wageningen Agricultural University, The Netherlands.

Appendix 40

Postharvest Technology Institute*

Location

4 Ngo-Quyen Street, Ha-Noi.

Mandate

The Postharvest Technology Institute (PHTI) undertakes research to establish the appropriate postharvest technologies for increasing the availability of food grains and food crops, and for reducing and preventing the postharvest losses.

Objectives

- To study the nature and degree of losses due to various factors, i.e. insects, rodents, birds etc, under different climatic conditions in Vietnam. Based on these research results, to develop appropriate technologies to reduce postharvest losses at different stages i.e. pre-storage, storage, processing etc.
- To investigate processing technologies for agricultural products.
- To conduct quality control in order to maintain standards and to increase quality of agro-products, particularly food grains.
- To develop educational programs and training courses for staff members.
- To transfer new postharvest technologies to farmers.
- To develop international cooperation.

Staff

Total 110 staff members, which includes 1 professor, 2 assistant professors, 2 doctors of science, 8 doctor candidates, 2 masters.

Structure

Currently the institute consists of nine departments:

- Department of Plant Physiology and Biochemistry,
- Department of Entomology,
- Department of Microbiology,
- Department of Drying,
- Department of Storage,
- Department of Milling,
- Department of Processing,
- Department of Utilisation of Agricultural By-Products,
- Department of Marketing and Economics.

The institute also directs:

- The Sub-Institute in Ho-Chi-Minh City,
- The Food Control Centre No 1, in Ha-Noi,
- The Food Control Centre No 2, in Ho-Chi-Minh City,
- The Technology Transfer, Design and Construction Centre,
- The Agricultural Extension Centre.

Research

National Postharvest Programs carried out by the Postharvest Technology Institute include:

- Program 20A. This program aims to provide instruction for the reduction of postharvest losses and improved food utilisation and includes nine research subjects.
- Program 02A. This program aims to provide instruction on food and foodstuff plants. It is responsible for research in agricultural product quality and in food grain storage, processing and quality control.
- Animal breeding program. Research on bran utilisation and damaged food grains and on methods to process them into animal feed and fermented animal feed.
- Establishment and inspection of standardised paddy rice and milled rice specialised equipment.

The specific research interests include:

- Plant physiology and biochemistry
  - Properties and quality of food grain, including marketing, cooking, eating and nutrition aspects.
  - Influence of external factors on grain quality.
  - The changes in quality of food grains during storage.

* Source: Post-Harvest Technology Institute outline.

- Study on the dynamics of hydrolytic enzymes and vitamins during the germination of some food grains (rice, corn, soybean, mung bean).

- Pre-storage
  - Improving pre-storage operations such as threshing, drying, cleaning, and grading at farm level.
  - Study of different methods of grain drying and comparative research on the different types of driers (flat-bed drier, continuous-flow drier, batch circulation driers, in-bin drier and locally-made driers).
  - Study of grain losses during drying operations and research on measures for reduction of these losses.
  - Study of the selection of criteria for dryers to be introduced.
  - Preparation of technical manuals for grain drying operation.

- Storage
  - Study of appropriate conditions of grain storage in respect of permanent stores, semi-permanent stores, temporary stores and open-yard piles.
  - Study of magnitude and causes of losses occurring during storage operations and research on measures for reduction of these losses.
  - Influence of storage conditions on grain quality.
  - Study on local conditions and appropriate types of godowns (grain stores) for construction.
  - Preparation of technical manuals for storage operations.

- Pest control
  - Influence of micro-organisms and insect infestation on grains during storage.
  - The influence of fumigants and insecticides on grain quality.

- Milling and processing
  - Methods of cleaning, grading and milling of paddy and rice and survey on existing rice mills in Vietnam.
  - Study of grain losses during processing operation and research on the measures for reduction of these losses.
  - Research on the influence of milling conditions on milled rice quality and breakage of rice.
  - Research on the influence of paddy quality on breakage of milled rice.
  - Study on the processing of cassava, potato, sweet potato, corn, soybean and peanut.
  - Preparation of technical manuals for rice milling operations.

- Quality control and standardisation
  - Study of the quality, grading and inspection system currently employed in Vietnam.
  - Study on the standardisation of food grains and establishment of Vietnamese standards for exportation and local consumption.
  - Preparation of technical manuals on grain inspection and grading.

- Biotechnology
  - Protein enrichment of cassava flour by solid state fermentation using *Aspergillus niger.*
  - Production of biopesticides using *Bauveria bassiana* and *Bacillus thuringiensis* for storage of rice as well as other food grains.

- Utilisation of waste and by-products
  - Survey of existing rice bran oil quality, characteristics, distribution etc.
  - Research on appropriate and effective methods of bran oil extraction.
  - Bran oil refining methods and improvement of bran oil quality and stability.
  - Preparation of technical manuals for extraction of refining methods of edible bran oil.
  - Research on other modes of utilisation of bran oil.
  - Research on utilisation of de-oiled rice bran.
  - Research on stabilisation methods of bran oil.

- Marketing and economy
  - Survey of the world rice market with reference to quality, price, selling systems, terms of sale, statistics, market trends etc.
  - Elaboration of appropriate measures to be taken by Vietnam and planning of implementation programs on varieties to be grown.
  - White rice quality, price, terms of sale, paddy collection system, international publicity, sales promotion activities etc.

Cooperation

- National universities and research institutes:
  - Vietnam Science Institute
  - Vietnam Agricultural Science Institute

- Rice Research Institute of the Mekong River Delta
- Food Crops Institute
- Genetic Institute
- Institute of Food Industries
- Ha-Noi Universities and Ho-Chi-Minh Universities
- Some biotechnology centres

- International research institutes and organisations:
  - IDRC IRRI (Canada)
  - IRRI
  - ACCT (France)
  - AIT
  - ICRISAT
  - ICC
  - AWRDC
  - CYMMIT
  - RAS
  - FAO
  - UNDP

Appendix 41

Postharvest Technology Institute of South Vietnam

Location

135 Pasteur Street, District 3, Ho-Chi-Minh City.

Activities

- Food and Commodities Control Centre II (FCC).

  The FCC was founded by the Ministry of Agriculture and Food Industry. It provides inspection services for most kinds of imports and exports and has a well equipped laboratory with qualified specialists in many fields of inspection. The Overseas Merchandise Inspection Company of Japan (OMIC) also cooperates with the institute.

  The FCC laboratory can meet the analysis and test requirements for international standards such as ASTM, OCS, AOAC, JAS and JIS.

- Manufacturing agricultural machinery.

  The institute has manufactured the following machines:
  - huller with the capacity of 200 kg/hour
  - grader
  - grinder with the capacity of 50 kg/hour
  - fine grinder with the capacity of 200 kg/hour
  - mixer
  - mixer with high capacity of 100 kg/hour
  - nutritious powder processor with the capacity of 300 kg/hour

- Extension services.

  The Institute conducts extension services to provide knowledge on storage and processing for the Mekong Delta, North East of Southern Region, Central Highlands and South Central Coast.

- Research.

  The Institute has completed research on the manufacture of silos with the capacity of 1000 t.

Appendix 42

Vietnam Agricultural Science Institute

Location

D7 Phuong-Mai, Dong-Da, Ha-Noi.

Mandate

- To conduct basic and integrated research work to establish agricultural development strategies in Vietnam by applying agricultural and agro-ecology systems.
- To transfer advanced technologies to production, under the diversified ecological conditions of the country.
- To train agricultural post-graduate fellows, technicians, and skilled workers.

Staff

The Institute has a total of 610 employees, of which 30 are senior scientists, 180 junior scientists, 330 technicians and workers. There are 70 administrative personnel.

Structure

The Institute consists of twelve departments:

- Department of Agro-Botany
- Department of Genetics and Plant Breeding
- Department of Plant Physiology
- Department of Agro-Ecology
- Department of Agricultural Microbiology
- Department of Water Management
- Department of Plant Biochemistry and Food Processing
- Department of Soil Chemistry
- Department of Genetics and Animal Breeding
- Department of Animal Physiology
- Department of Animal Nutrition
- Department of Biometry

The Institute also has four research centres:

- Vietnam-Soviet Centre for Plant Introduction and Breeding
- Rice Research and Development Centre
- Legume Research and Development Centre
- Potato and Vegetable Research and Development Centre

Research

- Strategies for agricultural development.
- Cropping systems for different ecologies.
- Rice varieties systems for different ecologies.
- Rice breeding for high yield crops, tolerant to adverse conditions (drought, flood, acid sulfate soil, low temperature, pests and diseases).
- Integrated technical practices for rice intensive farming.
- Introduction and selection of suitable wheat and barley varieties.
- Potato breeding and rapid multiplication of virus-free seeds.
- Soybean, groundnut and mungbean breeding and intensive farming practices.
- Increasing rice soil fertility.
- Development of agro-products processing models at household and cooperative levels.
- Germplasm evaluation and utilisation (rice, pulse, vegetable, industrial crops).
- Biological nitrogen fixation in lowland rice fields.
- Selection of high productivity animal breeds.
- Development of food supplements.
- Application of improved techniques to increase cattle productivity.

Development programs

- Agricultural systems of the Red River Delta.
- Systems of rice varieties for ecological regions (deep water, poor soils, acid sulfate soils).
- Integrated agricultural development of low-lying zones.
- Potato development program.
- Soybean and groundnut development programs.
- Intensive pig production program.
- System of agro-products processing at village-level.

International collaboration

The Institute has established a broad relationship with international research organisations and also has participated in international programs coordinated by:

- IRRI
- CIMMYT
- CIP
- ICRISAT
- All Union Institute of Plant Production (former USSR)
- INRA (France)

Appendix 43

Institute of Agricultural Sciences of South Vietnam (IAS)

Location

121 Nguyen Binh Khiem Street, District 1, Ho-Chi-Minh City.

Mandate

The IAS is the research coordination centre in South Vietnam and is a multi-commodity and leading research institute devoted to:

- Carrying out multi-disciplinary research on rice, maize, soybeans, groundnut, other grain legumes, vegetables, fruits, Irish and sweet potatoes, cassava, and jute.
- Improving the yield and carcass quality of pigs, poultry, buffalo and cattle.
- Developing highly efficient farming systems for various eco-agricultural areas in South Vietnam.
- Transferring economically suitable technology to advance cooperatives and farmers in different provinces.
- Assisting in the degree and non-degree training of scientific human resources.
- Collaborating with international and national research institutions for developing agriculture in South Vietnam.

Structure

The IAS is organised into ten departments/ centres:

- Department of Plant Breeding, including greenhouse and Cobalt 60 irradiation unit.
- Department of Vegetables, Fruits and Beans.
- Department of Soil and Plant Relationships, including two laboratories of Soil Analysis and Soil Microbiology.
- Department of Plant Protection, including three laboratories: Artificial Disease Contamination, Plant Disease Determination and Pesticide Testing.
- Department of Feedstuffs and Animal Nutrition, including two laboratories: Feedstuff Analysis and Animal Microbiology.
- Department of Pig and Poultry Husbandry.
- Department of Cattle Husbandry, including laboratory of Atomic Energy Applications in Agricultural Research.
- Department of Research Management, including Computer Centre and Science Documentation and Information Centre.
- Department of Corn Production.
- Research Centre of Farming Systems.

IAS also has four affiliated and regional centres:

- Centre of Training and Technology Transfer in Agriculture (CETTA).
- Hung-Loc Research Centre (Dong-Nai province) with 98 ha of cultivated land mainly devoted to upland crops and fruit trees.
- Binh-Thang Animal Research Centre (Song-Be province) with 6 ha mainly devoted to pig and poultry husbandry.

Dong-Thap-Muoi Research Centre (Long-An province) in the cradle of Plain of Reeds with more than 100 ha mainly devoted to deep water rice, jute, duck, buffalo and cattle husbandry.

International cooperation

- All Union Institute of Plant Production (former USSR).
- Tropical and Subtropical Agricultural Research, Institute of Czechoslovakia, Prague.
- INRA
- IRAT/CIRAD
- EIB/ACCT
- UCL
- FCD/FOS
- IRRI
- CIMMYT
- Asian Centre of CIP
- Asian Vegetables Research and Development Centre.
- AVRCD/TOP
- IAEA
- CIAT
- HEKS

Appendix 44

Plant Protection Research Institute (PPRI)

Location

Chem, Tu-Liem, Ha-Noi.

Mandate

The Institute undertakes research into all areas of pest management. Work at PPRI is highly practical and oriented towards the needs of farmers. Therefore much research at PPRI is linked to the activities of DPPP, which had responsibility for extension work on plant protection. It has associations and collaborations with other national agricultural research institutes and universities.

Staff

One hundred and fifty people are employed of which 14 have doctorates and 78 have bachelor of science qualifications.

Structure

- Division of Entomology: 20 members
- Division of Plant Pathology: 21 members
- Division of Pesticide Application and Weed Control: 18 members
- Division of Technological transfer: 12 members
- Division of Planing and communication: 12 members
- Biological Control Centre: 30 members

PPRI also has:

- an experimental station with 23 members; and
- field stations in South Vietnam and North Mountain.

Research

- Biological control in main agro-ecosystems. Research components for this include:
  - Survey, identification and use of natural enemies for pest (including weed) control. Mass production of some insect natural enemies such as *Trichogramma* spp.
  - Production of bio-pesticides.
- Identification and control of diseases of unknown ethology of rice such as:
  - Leaf yellowing (North Vietnam)
  - Premature ripening or yellow stripe (South and Central Vietnam)
  - Yellow stunt (Central Vietnam) and grain discolouration (North and Central Vietnam).
- Biology and interaction between main pests and natural enemies.
- Weed control by specific biological agents (insects, micro-pathogens).

PPRI also undertakes research for other crops (tea, coffee, vegetables, sugarcane, citrus, banana, and jute).

Appendix 45

Thu-Doc University of Agriculture and Forestry

Location

Thu-Duc, Ho-Chi-Minh City.

Staff

The university has 324 staff members, of which about 10% hold postgraduate degrees (12 professors).

Students

In 1991, the university had an enrolment of 3500 students in eight bachelor degree programs including agronomy, animal science, veterinary medicine, forestry, fishery, agricultural mechanisation, agro-forestry economics and sericulture.

The university also has seven graduate programs consisting of agronomy, soil chemistry, soil science, agricultural mechanisation, plant protection, animal science, veterinary medicine.

Mandate

The University's mandate can be classified into four categories of activities and objectives:

- To train technicians in agricultural fields with high academic standards and creativity.
- To carry out research, supporting efficient and sustainable use of agricultural and natural resources.
- To create an information centre to disseminate and extend proper and advanced agricultural knowledge and technology to farm communities particularly in the eastern part of South Vietnam, the Southern part of Central Vietnam, the Northern part of the Mekong Delta and the Western Highlands.
- To coordinate with other international institutes and organisations to assist in research and development activities leading to the economic improvement of the region.

Structure

The teaching and research facilities of the University are organised into seven faculties and 44 departments:

- Faculty of Agriculture:
  - Department of Plant Physiology and Biochemistry
  - Department of Genetics and Plant Breeding
  - Department of Paedology and Soil Chemistry
  - Department of Plant Protection
  - Department of Agriculture, Climatology and Water Management
  - Department of Food Crops
  - Department of Industrial Crops
  - Department of Horticulture
  - Department of Postharvest Technology
- Faculty of Animal Science and Veterinary Medicine:
  - Department of Animal Physiology and Biochemistry
  - Department of Animal Nutrition
  - Department of Genetics and Animal Breeding
  - Department of Zoo-technology
  - Department of Veterinary Anatomy, Surgery and Food Inspection
  - Dept of Veterinary Medicine, Pharmacology and Clinics
  - Department of Pathology, Microbiology, Parasitology and Infectious Diseases
- Faculty of Forestry:
  - Department of Silviculture
  - Department of Afforestation
  - Department of Forest Management
  - Department of Forest Exploitation and Transportation
  - Department of Wood Technology
- Faculty of Agricultural Mechanisation:
  - Department of Technical Mechanics
  - Department of Power Machinery
  - Department of Electricity and Electronics
  - Department of Agricultural Machinery
  - Department of Postharvest Machinery
  - Department of Machine-part Production
  - Department of Machine Repairing
- Faculty of Fisheries:
  - Department of Ecology
  - Department of Ichthyology
  - Department of Aquaculture
  - Department of Fish Processing

- Faculty of Agro-Forestry Economics:
  - Department of Organisation and Management
  - Department of Accounting
  - Department of Agriculture Planning and Projection
- Faculty of Basic Sciences:
  - Department of Mathematics
  - Department of Physics
  - Department of Chemistry
  - Department of Biology
  - Department of Informatics
  - Department of Foreign Languages
  - Department of Philosophy
  - Department of Physical Education

The university also has two experimental farms both on and off campus with a total area of 110 ha.

Research

Some funding for research in the University of Agriculture and Forestry comes from the Vietnamese government. Most of the research carried out has been funded by international or non-governmental organisations. The specific research interests include:

- Agriculture:
  - Selection and adaptation of improved paddy and upland rice varieties from IRRI.
  - Selection and adaptation of high yielding corn varieties from CIMMYT, Germany and Hungary.
  - Selection of high yielding varieties of soybean, mung bean, peanut, vegetables, sweet potatoes and cassava.
  - Selection of potential varieties of sugarcane, coffee, rubber and black pepper.
  - Studies on plant growth-regulating substances.
  - Studies on diseases of rice, vegetables, black pepper and tobacco.
  - Studies on the management of the problem soils of the Mekong Delta.
  - Research on water management on acid sulfate soils.
  - Research on dry season irrigation of upland crops in floating rice area.
  - Water balance study in rainfed area.

- Animal Science and Veterinary Medicine:
  - Research on the adaptability of imported breeds of livestock (poultry, duck, swine, dairy cattle) in South Vietnam.
  - Research on animal nutrition of swine, dairy cattle and chicken.
  - Research on forage crops.
  - Research on the supplementation of olingo elements in the feed of poultry, swine and dairy cattle.
  - Study of the epidemiologic maps of infectious diseases of livestock in South Vietnam.
  - Study of the animal parasitic map of South Vietnam.
  - Research on bee diseases.
  - Research on intensifying livestock and fuel production in Vietnam by making better use of local resources.

- Forestry:
  - Reforestation of devastated lands.
  - Selection and multiplication of special local forest trees.
  - Research on forest land management.
  - Research on wood preservation and processing.
  - Biomass studies of indigenous and exotic legume trees in South Vietnam.
  - Establishing sustainable agro-forestry demonstration farms in rolling hills and upland in South Vietnam.
  - Establishing a long-term agro-forestry system in An-Phu village, Thuan-An district and Song-Be province in South Vietnam.

- Fisheries:
  - Research on fish and shrimp feed.
  - Research on aquaculture on coastal area, in the eastern provinces of South Vietnam.
  - Fishing classification in the Dong-Nai River, Saigon River and Mekong River.

- Agricultural mechanisation:
  - Research on soil preparation for rice, maize, and pineapple production.
  - Modification of IRRI designed harvesters for better use in local conditions.
  - Research on grain dryers.

- Agro-Forestry Economics:
  - Studies on the role of family economy in socialist society in Vietnam.
  - Studies on contract-based systems in agricultural cooperatives.
  - Research on economic efficiency of different farming systems, rainfed upland farming systems and integrated home gardens, aquaculture and livestock production.

– Survey on cassava and sweet potato production in South Vietnam.

– Research on the economics of the *Apis mellifera* bee-keeping system in South Vietnam.

Extension

- Research results and adapted new technologies are distributed to state farms and small holding farms through the Quarterly Journal of Agricultural Sciences and Techniques of the University, through radio and television broadcasting programs, by the organisation of seminars and workshops to discuss technical subjects with local scientists and farmers, by the organisation of short training courses for farmers, by the implementation of pilot projects with the participation of the University's students and local farmers.
- Many high yielding rice varieties from IRRI, have been transferred to farmers by staff members of the Faculty of Agronomy.
- The Faculty of Animal Science has produced different kinds of pre-mix to improve poultry, swine, and dairy production.
- The Faculty of Forestry trains forest technicians on post-war reforestation planning, to restore the forest in the war devastated areas of South Vietnam such as the An-Phu village project, the Vinh-Tan village project and the Bau-Can village project.
- The Faculty of Fisheries has organised training courses on prawn production for farmers in Vung-Tau and Can-Gio districts.
- In order to transfer technologies, the University of Agriculture and Forestry collaborates closely with the provincial Agricultural Services of Dong-Nai, Song-Be, Tay-Ninh, Lam-Dong, Thuan-Hai, Long-An, Tien-Giang, Ben-Tre and many state farms in the suburbs of Ho-Chi-Minh City such as Le-Minh-Xuan, Pham-Van-Hai, and Nhi-Xuan state farms, Dong-A, Vinh-An, Go-Sao, and Phuoc-Long swine state farms, Binh-An and 19-8 poultry state farms, An-Phuoc and Duc-Trong dairy state farms. Collaboration with these agencies has brought fruitful results.

Cooperation

National universities and research institutes:
- Institute of Agricultural Sciences of South Vietnam
- University of Can-Tho.

Overseas universities and research institutes:
- Catholic University Louvain La Neuve, Belgium
- University of Agriculture, Brno, Czechoslovakia
- INA, France
- CTFT
- Centre d'Information et de Documentation en Agronomie des Regions Chaudes (CIRAD), France
- Ecole Nationale Veterinaire Maisons Alfort, France
- Karl Marx Universitat, Leipzig, Federal Republic of Germany
- Godollo University of Agricultural Sciences, Hungary
- Wageningen Agricultural University, Netherlands
- CLSU, Philippines
- UPLB, Philippines
- Swedish University of Agricultural Sciences
- Chiang Mai University, Thailand
- Khon Kean University, Thailand
- Kasetsart University, Thailand
- University of Hawaii, Manoa, USA
- East–West Center, Hawaii, USA

International research institutes and organisations:
- AAACU
- AIT
- CIAT
- ESCAP, CGPRT Centre
- International Committee for Co-ordination of Investigations of the Lower Mekong Delta Basin
- IDRC
- IIRR
- CIP
- IRRI
- SUAN
- Winrock International Institute for Agricultural Development
- Swedish Agency for Research Cooperation with Developing Countries

Non-government organisations (NGOs):

- Adventist Development and Relief Agency
- Bread of the World
- Cooperative Internationale pour le Development et la Solidarite
- Cooperative Services International
- Committee for Science and Technology for Vietnam
- Mennonite Central Committee
- World Vision International

Appendix 46

Can-Tho University

Location

Can-Tho University (CU) is located at Can-Tho province, the second largest city in South Vietnam.

Staff

The University has 710 teaching staff members.

Students

CU currently enrols 4500 regular students at its three main campuses at Can-Tho and 2000 students at five in-service-training colleges.

Mandate

CU is a multi-dimensional university operation conducting education, research and public service programs especially for the Mekong Delta region.

Structure

CU has 13 faculties offering course work leading to bachelor's degrees in 23 fields of study in agriculture, education and medicine; master's in agriculture and microbiology; and a number of certificates.

The University also jointly established with five provinces in the Mekong Delta, five in-service-training colleges which offer special programs of study leading to bachelor's degrees.

CU also has five specialised centres for research and vocational training:

- Biological Nitrogen Research Centre
- Electronics and Information Science Centre
- Mekong Delta Farming Systems Research and Development Centre
- Renewable Energy Centre
- Foreign Languages Centre

In addition, there are experimental stations and several pilot production units.

Faculties and departments

Agricultural Sciences

Consists of 1500 students and 250 teaching staff members.

- Faculty of Agronomy:
  - Department of Genetics and Plant Breeding
  - Department of Crop Science
  - Department of Soil Science
  - Department of Plant Physiology
  - Department of Plant Protection

- Faculty of Animal Husbandry and Veterinary Science:
  - Department of Genetics and Zoo-techniques
  - Department of Animal Anatomy and Physiology
  - Department of Parasitology and Internal Diseases
  - Department of Bacteriology and Epidemiology
  - Department of Animal Nutrition and Feeds

- Faculty of Food Science and Technology:
  - Department of Food Technology
  - Department of Food Engineering
  - Department of Food Processing

- Faculty of Fisheries:
  - Department of Ichthyology
  - Department of Fresh Water Aquaculture
  - Department of Mariculture
  - Department of Marifishing
  - Department of Hydrobiology

- Faculty of Agricultural Engineering:
  - Department of Farm Machinery
  - Department of Electricity
  - Department of Basic Engineering
  - Department of Machine Shop
  - Department of Metallic Servicing

- Faculty of Water Management and Land Reclamation:
  - Department of Irrigation and Drainage
  - Department of Geology Engineering
  - Department of Hydraulics
  - Department of Surveying

- Faculty of Economics:
  - Department of Statistics
  - Department of Agricultural Planning
  - Department of Production Management
  - Department of Agricultural Organisation
  - Department of Accounting Economics
  - Department of Commercial Economics

Education

Consists of 2000 students and 300 teaching staff members.

- Faculty of History–Geography
  - Department of History
  - Department of Geography
  - Department of Psychology

- Faculty of Mathematics–Physics
  - Department of Mathematic Teaching Methodology
  - Department of Algebra
  - Department of Calculus
  - Department of Advanced Geometry
  - Department of Biometry and Computer Sciences
  - Department of Fundamental Physics
  - Department of Theoretical Physics
  - Department of Technical Physics
  - Department of Teaching Methodology

- Faculty of Chemistry–Biology
  - Department of Organic Chemistry and Biochemistry
  - Department of Physic Chemistry
  - Department of Inorganic and Analytical Chemistry
  - Department of Botany
  - Department of Zoology
  - Department of Animal Physiology
  - Department of Agricultural Technology
  - Department of Teaching Methodology

- Faculty of Foreign Languages
  - Department of French
  - Department of English
  - Department of Russian

- Faculty of Letters
  - Department of Vietnamese Literature
  - Department of Foreign Literature

Medical sciences

Consists of 1000 students and 160 teaching staff members.

- Faculty of Medicine
  - Department of Internal Diseases
  - Department of External Diseases
  - Department of Paediatrics
  - Department of Obstetrics
  - Department of Human Physiology
  - Department of Diseases Physiology
  - Department of Dental Clinics

International assistance and cooperation

- Sister relationships
  - Agricultural University in Kuban, USSR
  - Odessa State University, USSR
  - Odessa Medical University, USSR
  - Olstyn Agricultural Sciences Institute, Poland
  - University of Hawaii, USA
  - University of Wisconsin, Madison, USA
  - Michigan State University, USA
  - Asian Institute of Technology (AIT), Bangkok, Thailand
  - Kasetsart Agriculture University, Thailand

- Non-govenmental organisations
  - US Committee for Scientific Cooperation with Vietnam, USA
  - Mennonite Central Committee, USA and Canada
  - Bread for the World, Federal Republic of Germany
  - Church World Service, USA
  - Heifer Project International, USA
  - Oxfarm America, USA
  - SAREC, Sweden
  - Terre des Hommes, Federal Republic of Germany
  - Cooperative Services International, USA
  - The Dutch Committee on Technical Cooperation with Vietnam, Netherlands

- International research organisations
  - IRRI
  - SUAN
  - INRA
  - University Paris-Sud, Centre d'Orsay, France
  - University Lyon I
  - CNRS Museum National, France
  - ORSTOM, France

- Wageningen Agricultural University, Netherlands
- Louvaine-la-Neuve Catholic University, Netherlands
- Agricultural Institute of Gembloux, Belgium
- FAO

Appendix 47

Vikyno Factory

Location

Bien-Hoa (30 km northeast from Ho-Chi-Minh City).

Staff

300 employees including 35 experienced engineers.

Capital

Fixed assets of US$2.5 million.

Structure

- A main factory with 9000 m^2 of floor space containing a machine shop, sheeting and welding shop, jigs and dies shop, repair shop and assembly shop with more than 150 machine tools.
- A heat treatment factory with an area of 960 m^2, salt bath treating equipment and high frequency head inducing equipment.
- A foundry and forging workshop.

Equipment manufactured

- Small diesel engines, water pumps and gear boxes.
- Wood processing machines and special metal cutting machine tools.
- Precision mechanical parts which have a sealed contact.
- Diesel engines, Model D9 (9 hp), DV12 (12 hp) and KND5B (6 hp).

In 1992, the production program was 2700 engines in three types. In manufacturing diesel engines the factory needs to be modernised and expanded to reach the annual production output of 10 000 units to meet the local demand.

Research and development

- Rice-dryers. The factory is studying four designs of dryers and intends to produce pilot models based on:
  - The SD8B from Japan, which has a productivity of 400 kg/batch. The moisture content is reduced from 22% to 14% in 6 hours using rice husks for fuel.
  - The TURBO model from France, which can be driven by a 50 hp tractor and is transportable. The capacity is 1.2 t every 6 hours and gasoil is used as fuel.
  - The stationary model from the Japanese Satake, which has an output of 2.5–3 t per 8 hours.
  - The silo-dryer which uses gasoil for fuel and has the capacity to handle 2 t of rice per hour.
- Maize-dryers. This dryer can reduce the moisture content of 40 t of maize per day from 30% to 22%. Wood, which is plentiful in most maize growing areas, is used as fuel.
- Coffee-dryers. Household scale, using wood as fuel.

Appendix 48

Centre of Analytical Services and Experimentation

Location

Nguyen Van Thu Street, Ho-Chi-Minh City.

Services

- Analysis of different constituents in raw materials and final processed products.
- Identification and quality control of products.
- Structural study of complex products in different fields (industry, agriculture, resources, environment, pharmacy, health, and aesthetics).
- Setting up or upgrading of processes of production.
- Research into, and production of, new materials.
- Training of laboratory technicians.

Analytical substances

- Organic substances: essential oils, perfumes and aromas, cosmetics, detergents, emulsifiers, plastics, paints, varnishes, adhesives, additives for plastics and foods, plant growth hormones, herbicides and pesticides.
- Inorganic substances: minerals, metals, alloys, and fertilizers.
- Agricultural products and foodstuffs: proteins, lipids, glucides and vitamins.
- Pharmaceutical products.
- Petroleum: crude and refined oils, impurities.
- Trace elements in soils, fertilizers, foods, water, human organs, pesticide residues on fruits and vegetables.
- Identification of unknown chemicals.
- Quality control of imports, exports and locally consumed products.

Techniques

Techniques of elemental analysis

Inorganic:

- Plasma Atomic Emission Spectrometer (ICP).
- Atomic Absorption Spectrometer (AAS).

These instruments allow the identification and titration of about 70 elements at any concentration (from major to trace elements).

Organic:

- C, H, N, S, Halogens Analysers allowing automatic, rapid and precise analysis with small quantities of products (0.5–2 mg).

Techniques of molecular analysis

- Gas chromatography (GC) with capillary column.
- High performance liquid chromatography (HPLC).
- Gel permeation chromatography
- Fourier transform infrared spectrometry (IRFT) with possibility of coupling technique GC-IRFT.

Appendix 49

Industrial Foodstuff Institute

Location

8 Nguyen Trai street, Ha-Noi

Mandate

The Industrial Foodstuff Institute's mandate is to conduct research and services for the public and industry in the field of food processing.

Staff

There are 200 staff members, 60% of the staff are at university level or above.

Structure

The Institute is organised into departments as follows:

- Microbiology: identify species of bacteria.
- Biochemistry: research on amino acids and organic acids, e.g. monosodium glutamate and lactic acid.
- Enzyme: research on hydrogenation of protein.
- Fatty acid: research and processing of fatty acids contained in foods.
- Food technology: processing of food from cereal.
- Natural components: research on herbs and spices.
- Packaging.
- Bio-technological products: research and development.
- Instrumentation: process in pilot scheme before transferring the technology for mass production by industry.

The Institute also has one sub-institute in Ho-Chi-Minh City.

Appendix 50

National Institute of Nutrition

Location

48 Tang Bat Ho, Ha-Noi.

Structure

The Institute is organised into departments and sections as follows:

- Food Composition Analysis and Food Safety Department
  - Food composition analysis
  - Food quality and hygiene inspection
  - Food toxicology: research on food additive and pesticide residue
  - Food microbiology: research on aflatoxin
  - Instrumentation

- Community Nutrition Department
  - Nutrition for mothers and children
  - Nutrition for occupational groups
  - Growth monitoring and promotion
  - Biochemistry: control of nutritional anaemia
  - Nutritional physiology

- Applied Nutrition
  - Nutritional surveillance
  - Program for controlling vitamin A deficiency and xerophthalmia
  - Nutritional education and communication
  - Diet therapy

- Diet Therapy Department
  - Clinic: malnourished children and nutritional rehabilitation
  - Nutrition for elderly people
  - Diet therapy.

Appendix 51

Ministry of Fisheries

Location

57 Ngoc-Khanh, Ba-Dinh, Ha-Noi.

Staff

The total scientific and technical staff currently number 6840 people including:

- 74 postgraduates
- 3540 university graduates and
- 3230 graduates from vocational schools and technical schools.

Structure

At present, the Ministry of Fisheries has:

- four research institutes
- one research centre
- one fisheries college
- one centre of economic and technical information
- one fisheries vocational training school and
- three technical schools for training technical workers and personnel for the fisheries sector.

Research needs

- Red River Delta
  - Yen-Hung aquaculture farm.
  - Shrimp culture for export.
  - Development of market shrimp culture, shrimp hatchery production.
  - Aquaculture in Nghe-An seashore.
  - Technology of grouper and seabass cage culture and fry production in coastal areas.
  - Rational exploitation and and farming of sea molluscs.
  - Establishment in Hoa-Binh of a hydropower-plant reservoir as a model for grassroots fisheries.
  - Shrimp culture in North Vietnam seawaters.
  - Processing of high-quality fishmeal.
  - Upgrading the fisheries centre for improved extension of information for fisheries development.
  - Harvesting and processing of marine products.
  - Mechanical engineering and logistics support for fisheries.
  - Offshore fishing.

- Central coastline and western plateau regions
  - Surveys, exploitation, processing and protection of lobster resources in Quang-Binh sea waters.
  - Support for lobster exploitation, breeding and raising.
  - Semi-intensive black tiger shrimp (*Peneus monodon*) culture.
  - Brackish water shrimp culture.
  - Development of pond and lakes culture of fish in western plateau area.
  - Assistance in the use of enzyme products in aqua-products processing in Vietnam.
  - Offshore marine fishing.
  - Port servicing and ship building and repair in the central part.
  - Assistance to fishery communities in Vietnam's central part.
  - Technical support for scallop exploitation, culture and processing.

- Mekong River Delta
  - To develop export shrimp farming in coastal areas, from Bac-Lieu to Ganh-Hao.
  - Development of semi-intensive shrimp culture.
  - Shrimp culture and processing for export.
  - Development of brackish water shrimp culture in Tra-Vinh province coastline.
  - Shrimp culture in Phuoc-Co.
  - Shrimp culture zone in Giong-So.
  - Development of export shrimp culture.
  - Construction of fishing and fisheries service centre in Vung-Tau.
  - Construction of a fisheries ship-building and repair complex.
  - Construction of a trade port for fisheries product imports and exports in Nha-Be.
  - Development of nylon fibre production.
  - Improvement of refrigeration capacity for food preservation, spoilage prevention and domestic use.
  - Group of marine products processing facto-

ries SEAREFICO (frozen and dried marine products).

- Support for research in environment and fish disease prophylaxis and treatment.
- Aquaculture breeding and rearing experimental centre, Mekong River Delta.
- Technical assistance with methods of quality control and certification of netting materials.
- Innovations in economic management research and macro economic analysis of fisheries policies.
- Research in marine biological resources, measures for efficient exploitation and protection of Vietnam's off-shore resources.
- Overall survey and planning in the central provinces.
- Survey and planning for aquaculture development in the Red River Delta.

ACIAR Technical Reports

No. 1 ACIAR Grain Storage Research Program: research report 1983-84, 63p., 1985.

No. 2 Pastures in Vanuatu, D. Macfarlane and M. Shelton, 32p., 1986.

No. 3 ACIAR Grain Storage Research Program: research report 1984-85, 85p., 1986.

No. 4 Coconut germplasm in the South Pacific Islands, M.A. Foale, 23p., 1987.

No. 5 South Pacific agriculture: challenges and opportunities for ACIAR and its research partners, G.J. Persley and P. Ferrar, 87p., 1987.

No. 6 ACIAR Grain Storage Reseach Program: research report 1985-86, 96p., 1987.

No. 7 Building on success: agricultural research, technology, and policy for development: report of a symposium held at Canberra, 14 May 1987, J.G. Ryan, 39p., 1987.

No. 8 New technologies for rainfed rice-based farming systems in the Philippines and Sri Lanka: report of a workshop held at Iloilo, Philippines, 20-24 July 1987, 39p., 1988.

No. 9 Gaseous nitrogen loss from urea fertilizers in Asian cropping systems, J.R. Freney, J.R. Simpson, Zhu Zhao-liang and Aziz Bidin, 16p., 1989.

No. 10 Bulk handling of paddy and rice in Malaysia: an economic analysis, G.J. Ryland and K.M. Menz, 32p., 1989.

No. 11 Economic prospects for vanilla in the South Pacific, K.M. Menz and E.M. Fleming, 14p., 1989.

No. 12 Biological control of *Salvinia molesta* in Sri Lanka: an assessment of costs and benefits, J.A. Doeleman, 14p., 1989.

No. 13 Rainfed rice production in the Philippines: a combined agronomic economic study of Antique Province, K.M. Menz, 90p., 1989.

No. 14 Transport and storage of fruit and vegetables in Papua New Guinea, K.J. Scott and G. Atkinson, 22p., 1989.

No. 15 Marketing perspectives on a potential Pacific spice industry, Grant Vinning, 59p., 1990.

No. 16 Mineral nutrition of food legumes in Thailand with particular reference to micronutrients, R.W. Bell et al., 52p., 1990.

No. 17 Rice production in Sri Lanka, K.M. Menz (ed.) 51p., 1990.

No. 18 Post-flask management of tissue-cultured bananas, Jeff Daniells and Mike Smith, 8p., 1991.

No. 19 The utilisation of remote sensing in the South Pacific, D. van R. Claasen, 59p., 1992.

No. 20 Hybridisation techniques for acacias, Margaret Sedgley, Jane Harbard and Rose-Marie Smith, 11p., 1992.

No. 21 Production of pathogen-tested sweet potato, Peter Beetham and Angela Mason, 47 p., 1992.

No. 22 Plants fed to village ruminants in Indonesia, J.B. Lowry, R.J. Petheram and B. Tangendjaja (ed.), 60p., 1992.

No. 23 Allozyme electrophoretic methods for analysing genetic variation in giant clams (Tridacnidae), J.A.H. Benzie, S.T. Williams and J.M. Macaranas (ed.), 48p., 1993.

No. 24 Tuna baitfish and the pole-and-line industry in Kiribati, N.J.F. Rawlinson, D.A. Milton and S.J.M. Blaber, 92p., 1993.

No. 25 Economic aspects of raw wool production and marketing in China, J.W. Longworth (ed.), 62p., 1993.