The Structure, Conduct and Performance of the Seed Industry in Thailand

Suthad Setboonsarng
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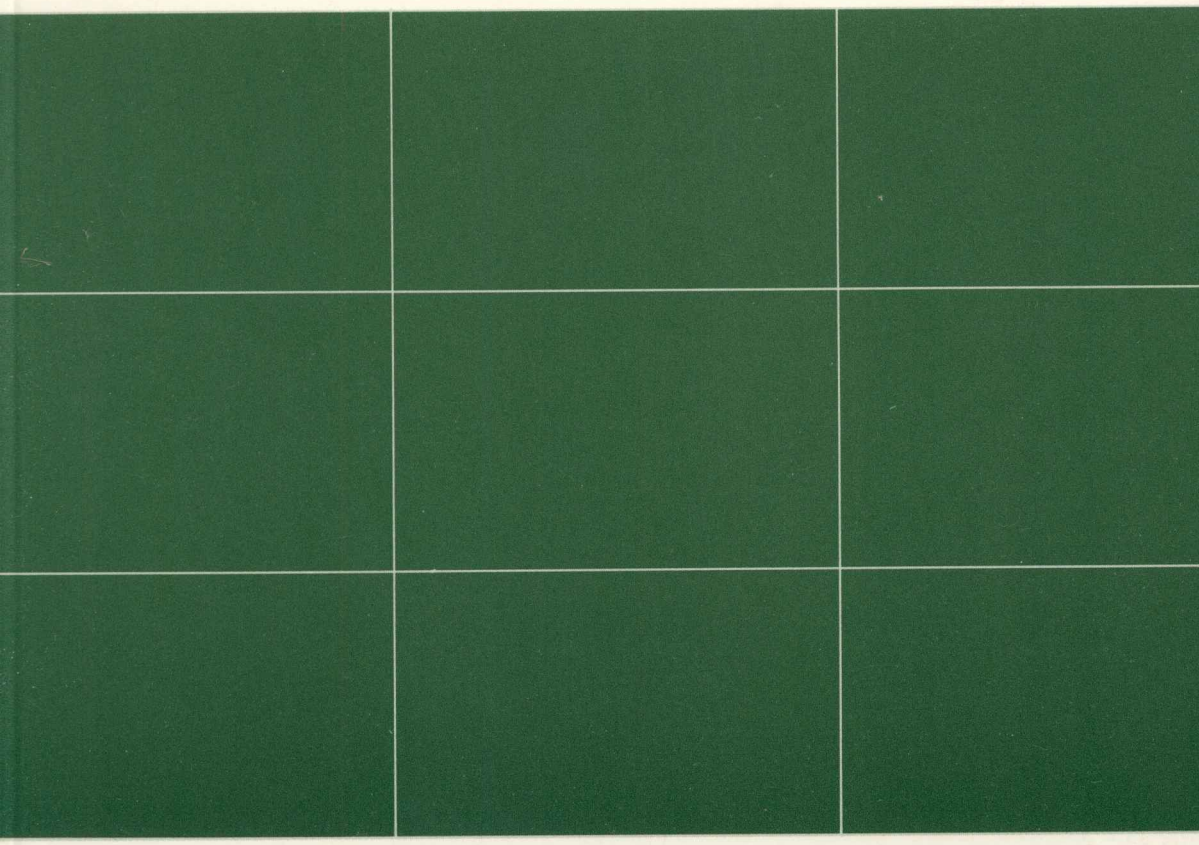

The Thailand Development Research Institute
Research Monograph No. 5

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ISBN 974-88647-1-5

Published by
The Thailand Development Research Institute Foundation
Rajapark Building
163 Asoke, Sukhumvit Road
Bangkok 10110 THAILAND

Printed in August 1991
Printed in Thailand

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This book has been externally reviewed and refereed. It presents the views of the authors and does not necessarily reflect the views of the Thailand Development Research Institute.

Contents

page

List of Tables vii
List of Figures ix
Foreword xi
Acknowledgements xiii
Executive Summary (English) xv
Executive Summary (Thai) xvii
Chapter 1 Introduction 1
Chapter 2 The Thai Economy and the Seed Industry 5
ECONOMIC PERFORMANCE 5
TRADE AND THE AGRICULTURAL SECTOR 5
THE AGRICULTURAL SECTOR AND CROP PRODUCTION . . 7
CROP PRODUCTION AND LAND USE 8
SEED REQUIREMENTS 10
SEED TRADE 12
GOVERNMENT POLICIES AND THE SEED MARKET 13
Chapter 3 Structure of the Seed Industry 17
ORGANIZATION OF IMPROVED SEED IN THE PUBLIC SECTOR 17
STRUCTURE OF THE PRIVATE SEED INDUSTRY 24
Chapter 4 Conduct of the Seed Industry 31
CONDUCT OF THE PUBLIC SEED SECTOR 31
CONDUCT OF THE PRIVATE SEED SECTOR 34
VEGETABLE SEED MARKETS 40
Chapter 5 Performance of the Seed Industry 43
PERFORMANCE OF THE PUBLIC SEED PROGRAM 43
THE PRIVATE SEED INDUSTRY 45
THE ADOPTION OF IMPROVED SEEDS 46
PLANT VARIETY PROTECTION 47
PROBLEMS FACING THE PRIVATE SEED INDUSTRY 48
Chapter 6 Conclusions and Recommendations 49

page

Appendix A: The Organization of Research in Plant Breeding 51
Appendix B: The Development of Improved Rice Seed 55
Appendix C: The Development of Improved Corn and Sorghum Seeds . . . 59
Appendix D: The Development of Improved Soybean Varieties 65
Appendix E: The Development of Improved Groundnut Seed 69
Appendix F: The Development of Improved Mung Bean Seed 75
Appendix G: The Development of Improved Tomato Seed 79
Appendix H: The Survey 81
References 83

List of Tables

Table No.		page
2.1	Average Annual Growth Rate	6
2.2	GDP Share of the Major Economic Sectors	6
2.3	Structure of Exports, 1960-1985	7
2.4	Value Added in Agriculture and Share of Each Component	8
2.5	Average Cultivated Areas of Major Crops	9
2.6	Distribution of Land Holdings By Size of Holdings	9
2.7	Seed Requirements	10
2.8	Field Crop and Vegetable Seed Situation in Thailand, 1986	11
2.9	Field Crop and Vegetable Seed Supply By Seed Division, 1986-1987	11
2.10	Import and Export of Seeds	12
2.11	The Production of Foundation Seed by the Department of Agriculture	13
3.1	Seed Centers of the Seed Division in 1986 and Sources of Funds	20
3.2	Improved Seed Produced by the Seed Division	22
3.3	Production of Seed by the National Corn and Sorghum Research Center, Kasetsart University, 1982-1986	23
3.4	Number and Percentage of Seed Companies, Classified by Activity, 1987	24
3.5	Number of Years in Business and Number of Employees of the Major Groups of Seed Companies	26
3.6	Year of Establishment, Registered Capital and Crops of the Major Field Crop Companies in Thailand	27
3.7	Foreign Partners of Major Field Crop Seed Companies	28
3.8	Types of Registered Vegetable Seed Companies, 1984-1985	29
3.9	Custom Seed Production Companies	30
4.1	Share of Seeds Produced by the Seed Division, 1987	32
4.2	Distribution of Seeds by the Seed Division, 1987	34
4.3	Selling Price of Improved Seed of Public and Private Seed Companies, 1986 and 1987	37
4.4	Research Budget and Staff of the Field Crop Companies	38

Table No. **page**

4.5 Seed Production by the Private Sector 38
4.6 Share of Seed in Total Company Sales and Share of Certified Seed in Seed Sales 38
4.7 Distribution Channels of the Private Seed Companies 39
5.1 Adoption of Modern Rice Varieties in Selected Areas 47
5.2 Adoption of Improved Corn Seed in Major Cultivation 47
B.1 Recommended Rice Varieties Classified by Type of Cultivated Area . . 57
C.1 Development of Suwan 1 and Suwan 2 60
D.1 Soybean Varieties in 1951-1959 66
D.2 Characteristics of Soybean Varieties 67
D.3 Dominant Features of Sukhothai 1, OCB, S.J.4 and S.J.5 68
E.1 Characteristics of Groundnut Varieties 73
F.1 Characteristics of Kamphaengsaen 1, Kamphaengsaen 2 and U-Thong 1 78
F.2 Some Characteristics of U-Thong 2 and a Local Variety 78
H.1 Distribution of the Sampled Seed Companies 81
H.2 Classification of Private Seed Companies by their Activities 82

List of Figures

Figure No.		Page
3.1	Organization and Administration of Seed Development Project	18
3.2	Organization Chart of Seed Division	19
3.3	Seed Centers in Thailand	21
4.1	Distribution of Seed from the Public Sector	33
A.1	Rice Research Centers	53
A.2	Field Crop Research Centers	54

Foreword

The existence, nature and health of the seed industry is of public policy concern. The government has expended resources into agricultural research, which has borne fruit in different ways, probably the most important of which is in better seeds. The seed industry is thus an important conduit for new technology. It plays a strategic role, even though it is not a very large industry, in terms of sales.

While the public sector is and will continue to be involved in seed production and distribution, the private sector has been playing an increasingly indispensable role. As the industry develops and matures, it will probably expand beyond its current role as producer and distributor, and will conduct its own research, thus generating technology, but it will do so selectively and for some crops only. Public policy issues concerning agricultural research and technology will have to be recast. This baseline description of the seed industry could then prove indispensable.

This study is part of TDRI's ongoing interest in the generation and propagation of new agricultural technology. A previous monograph has looked at the system of extension (Agricultural Information and Technological Change in Northern Thailand, edited by Mingsarn Kaosa-ard, Kanok Berkasem, and Chaiwat Roongruangsee, Research Monograph No. 1, TDRI, 1989). Nearing completion is a study on the setting of agricultural research priorities. The institute then hopes to draw together the results of these various studies to prepare a policy paper on agricultural research and technology.

Dr. Ammar Siamwalla
President
Thailand Development Research Institute
July 1991

Acknowledgements

The research for this project was funded by the Development Research Institute (IVO) of Tilburg University, the Netherlands. The authors deeply appreciate the cordial assistance and stimulating discussion of Dr. Anthony Groosman, the coordinator of this project. His warm personality and willingness to learn from and understand others is the major component for the success of the overall project. We would like to thank Holke Weirma for his efforts in producing the earlier version of this report as a discussion paper at IVO.

Many useful suggestions and comments from Dr. Ammar Siamwalla were important in shaping the conclusion of this paper. We thank him for his interest and for the time he spent voluntarily on this project.

The cooperation of both the Seed Division of the Department of Agricultural Extension and the personnel in the various seed companies we interviewed made our research enjoyable. We thank them all for their time and tolerance. We hope that the facts about their work are well portrayed in this report.

Last but not least, we would like to thank the anonymous outside referee of this paper, whose comments were constructive and substantial. We hope our corrections lived up to the quality of the comments.

Executive Summary

The Seed Division estimates that about 25 percent of the total seed used in Thailand (about 386 thousand tons) goes through the seed market. The remaining 75 percent is farmer-saved seed. The provision of seed by the public sector (the Seed Division, universities and the Department of Agriculture) accounts for about 5 percent of the total seed supply. The remaining 20 percent comes from private seed companies. About 2.5 percent of the seed from the private companies is imported, especially vegetable seed. At the same time, Thailand exports some vegetable seed (about 1.2 thousand tons in 1985).

The public sector plays at least three roles in the seed market: a) providing improved non-hybrid seed for the farmer; b) regulating the private seed companies; and c) training farmers to properly keep their seeds. New technology embodied in the improved seed varieties is transferred to farmers through the public seed program. This is particularly important because most of the seed used in Thai agriculture is non-hybrid, and private seed companies are not interested in these markets. Rice seed alone accounts for about 75 percent of the total seed requirement. Pricing of the seed sold by the public sector is used as a measure to control the price of hybrid seed from the private companies. The public sector is trying to become more neutral in the seed market and is shifting its emphasis to improving the capability of farmers to keep their seeds, which is the more important portion of the total seed market. The government has imposed an import tariff and given investment privileges to the seed companies to promote the domestic private seed sector.

Private seed companies dominate the vegetable seed market as most of the seed is imported. The seed market began its entry into the modern world in the late 1970s, when hybrid corn companies came on the scene. In the early 1980s, the soybean seed and aromatic rice seed companies launched their marketing activities. There are now over 130 registered seed companies. Most of the seed companies also sell other agricultural products. Seed sales account for less than half of their total sales revenue. The increase in the number of seed companies has made the competition in the market more acute. Farm demonstration has proved to be the most effective sales campaign. Seed quality has also become more important. While brand loyalty is important in the vegetable seed market, it is less important in the corn seed market, where price competition is severe.

Investment in establishing marketing channels for different seeds is an effective way to market new products and technology of the seed companies. Seed companies, especially foreign subsidiaries, put more emphasis on marketing investment than

on research. Marketing channels and brand names are ways to extract benefits from research in lieu of a plant variety protection law and a plant patenting system, non-existent in Thailand.

The increased participation of the private seed sector indicates that Thai farmers are becoming more commercially aware and sophisticated. The public sector in production and distribution should assume a more supportive role, especially when assisting farmers to keep their seeds. Quality control through a seed certification and monitoring system would also ensure that farmers get good-quality seed.

บทสรุป

กองขยายพันธุ์พืชของกรมส่งเสริมการเกษตรประเมินว่าประมาณร้อยละ 25 ของเมล็ดพันธุ์ทั้งหมดที่ใช้ในการเกษตรของไทย (ประมาณ 386,000 ตัน) มีการซื้อขายผ่านตลาดเมล็ดพันธุ์ ส่วนที่เหลืออีกร้อยละ 75 นั้น เป็นเมล็ดพันธุ์ที่เกษตรกรเก็บไว้เอง เมล็ดพันธุ์ประมาณร้อยละ 5 นั้นผลิตโดยภาครัฐบาล (เช่น กองขยายพันธุ์พืช มหาวิทยาลัยต่างๆ และกรมวิชาการเกษตร) อีกร้อยละ 20 เป็นเมล็ดพันธุ์จากบริษัทเมล็ดพันธุ์ต่างๆ ในจำนวนเมล็ดพันธุ์ที่มีการซื้อขายกันนั้นประมาณร้อยละ 2 มาจากการนำเข้า ในขณะเดียวกัน ประเทศไทยก็มีการส่งออกเมล็ดพันธุ์ (ประมาณ 1.2 พันตันในปี พ.ศ. 2528)

บทบาทของภาครัฐบาลในตลาดเมล็ดพันธุ์มีอย่างน้อย 3 ด้านคือ การให้เมล็ดพันธุ์ (ที่ไม่ใช่เมล็ดพันธุ์ลูกผสม--NON HYBRID-SEED) แก่เกษตรกร การควบคุมการซื้อขายเมล็ดพันธุ์ และการฝึกอบรมเกษตรกร การแจกจ่ายเมล็ดพันธุ์พืชเป็นการเผยแพร่วิทยาการและผลงานวิจัยซึ่งเก็บอยู่ในรูปเมล็ดพันธุ์ไปสู่เกษตรกร ตลาดเมล็ดพันธุ์ผสมเปิดนั้น บริษัทเอกชนไม่สนใจเพราะเกษตรกรจะไม่หวนกลับมาซื้อเมล็ดพันธุ์อีกในปีถัดไป เนื่องจากเก็บเมล็ดไว้ใช้ต่อๆ ไปได้ ตลาดที่ใหญ่มากคือตลาดข้าว ซึ่งเป็นปริมาณประมาณร้อยละ 75 ของตลาดเมล็ดพันธุ์ทั้งหมด การตั้งราคาของเมล็ดพันธุ์ของภาครัฐบาลเป็นวิธีการควบคุมราคาของเมล็ดพันธุ์ลูกผสมไปด้วย ปัจจุบันรัฐบาลได้เริ่มให้ความสนใจที่จะอบรมให้เกษตรกรรู้จักการเก็บรักษาเมล็ดพันธุ์ให้ดีขึ้น เพราะนั่นเป็นเมล็ดพันธุ์ส่วนใหญ่ที่ใช้ในแต่ละปี นอกจากรัฐบาลจะควบคุมคุณภาพของเมล็ดพันธุ์แล้ว ยังเก็บภาษีนำเข้าเมล็ดพันธุ์ และให้สิทธิพิเศษแก่การลงทุนด้านเมล็ดพันธุ์พืชด้วย ซึ่งนับเป็นการคุ้มครองและสนับสนุนอุตสาหกรรมการผสมเมล็ดพันธุ์ในประเทศ

ตลาดเมล็ดพันธุ์ผักนั้นเกือบจะอยู่ในภาคเอกชนทั้งหมด และเป็นกิจการที่ทำมานานแล้ว โดยส่วนใหญ่เป็นเมล็ดพันธุ์ที่ต้องนำเข้า ตลาดเมล็ดพันธุ์สมัยใหม่เริ่มเกิดขึ้นในราวปี พ.ศ. 2520 เมื่อกลุ่มบริษัทผลิตข้าวโพดลูกผสมเริ่มมาลงทุนในประเทศไทย กลุ่มบริษัทขายเมล็ดพันธุ์ถั่วเหลืองและข้าวเริ่มเกิดขึ้นในราวปี พ.ศ. 2525-2526 ปัจจุบันมีบริษัทเมล็ดพันธุ์ซึ่งจดทะเบียนไว้กว่า 130 บริษัท บริษัทเมล็ดพันธุ์ส่วนใหญ่จะขายปัจจัยการผลิตอื่นๆ (เช่น ปุ๋ยและยา) ไปพร้อมๆ กันด้วย รายได้จากการขายเมล็ดพันธุ์จะมีไม่เกินครึ่งหนึ่งของยอดขายทั้งหมด จำนวนบริษัทที่มีมากขึ้นหมายถึง การแข่งขันที่ดุเดือดมากขึ้น แต่วิธีการขายที่ให้ผล

มากที่สุดก็คงจะได้แก่การปลูกให้เกษตรกรได้เห็น ซึ่งแสดงว่าการแข่งขันด้านคุณภาพมีความสำคัญมาก เกษตรกรที่ปลูกผักมักจะติดอยู่กับยี่ห้อ ซึ่งต่างจากชาวไร่ข้าวโพดที่ความคล่องตัวกว่า ดังนั้นการแข่งด้านราคาใน เมล็ดพันธุ์ข้าวโพดจึงมีมากกว่า

การลงทุนสร้างช่องทางการจัดจำหน่ายในเมล็ดพันธุ์พืชต่างๆ เป็นอีกวิธี ซึ่งใช้ในการส่งเสริมการขาย และเป็นวิธีที่มีประสิทธิภาพสูงในการนำวิทยาการใหม่ๆ ของบริษัทเมล็ดพันธุ์ออกมาขาย บริษัทเมล็ดพันธุ์โดยเฉพาะที่เป็นสาขาของบริษัทต่างประเทศ จะเน้นการลงทุนด้านการตลาดมากกว่าการลงทุนด้านวิจัย ช่องทางการจัดจำหน่ายและยี่ห้อเป็นวิธีที่ใช้ในการเก็บผลประโยชน์จากการวิจัย แทนกฎหมายสิทธิของนักปรับปรุงพันธุ์หรือสิทธิบัตรพันธุ์พืชซึ่งประเทศไทยยังไม่มี

การขยายตัวของภาคเอกชนในตลาดเมล็ดพันธุ์ แสดงว่าเกษตรกรไทยเป็นนักการค้ามากขึ้น และมีความลึกซึ้งมากขึ้น บทบาทของภาครัฐบาลจึงควรจะเปลี่ยนมาพัฒนาคุณภาพของเกษตรกรให้ดีขึ้น รู้จักเลือกมากขึ้น และรู้จักเก็บเมล็ดพันธุ์ดีขึ้น การควบคุมคุณภาพของเมล็ดพันธุ์โดยระบบการจดทะเบียนพันธุ์พืชและการติดตามตรวจสอบ ก็จะทำให้เกษตรกรได้เมล็ดพันธุ์ที่มีคุณภาพที่ดีขึ้น

Chapter 1

Introduction

Prior to 1980, land expansion was the major source of growth for the Thai agricultural sector (Siamwalla, Pattamasiriwat and Setboonsarng, 1986). With fewer possibilities to develop new agricultural land, the role of new technology, particularly in the form of improved seed, has gained importance over the past decade as a new source of agricultural growth. Thus, the public and private sectors have paid more serious attention to the development of improved seed.

Not only does improved seed bring higher yields, but it can also give higher-quality grain and new crops. The higher-quality of grain and a more diverse crop mix have enabled many farmers to sustain their incomes and have provided flexibility to the agricultural system.

Most of the seed used in agricultural production is the seed that the farmers have selected and retained from the past harvesting season (commonly known as farmers' save seed). Commercial seed production is a relatively new activity in Thailand (Sarikaphuti, 1986). The public sector plays a major role in both the research and development of improved seed for many crops, especially for open-pollinated varieties such as rice. At the same time, the private sector's role in the industry has been growing very rapidly during the past five years, particularly in hybrid corn and sorghum. While vegetable seeds have always been under the private sector's control, the public sector is planning to increase its involvement in the vegetable seed market in the near future.

Almost all of the large private companies that entered the market during the late 1970s are subsidiaries of or joint ventures with foreign partners who have longer experience in the seed industry. In addition, many smaller Thai companies have entered into this industry, especially in the corn seed market. Recently, the fear of foreign domination in this industry and the agricultural sector's dependence on foreign seed supplies have stimulated the government to take a closer look at this industry.

U.S. pressure on Thailand to take plant seed from the patent exemption has caused further concern about the role of private foreign investment in the seed industry in Thailand. The change in the ownership structure of these companies in the developed countries (Groosman, 1987) is yet another source of concern about control of the private seed sector by foreign companies.

While information about the change in the world market structure is important for decision makers in both the public and private sectors, it is difficult to predict the effects of this change on the Thai seed market. Decision makers in both the public and private sectors should keep each other informed about these changes in

order to devise appropriate policies that can enhance sound development of the seed industry in Thailand.

Although there is little doubt that sound development of the seed industry is a key factor in stimulating the growth of crop production, there is no clear direction for the promotion of this industry. The government's objectives are to provide quality seed for the farmer and to promote the development of the private seed industry. However, present government action may not lead to these targets. For example, expansion of the public seed production program may hamper development of the private seed sector. Thus, the public sector's role in promoting sound development of the seed industry in Thailand is an important question that policy makers need to address.

The first step in answering the above questions is to gain a better understanding of the current structure and behavior of the seed industry in Thailand. This information can then be used to determine the necessary short- and medium-term steps that need to be taken in order to develop the seed industry in this country.

OBJECTIVE

The objective of this study is to describe the structure, conduct and performance of the seed industry in Thailand. The results will shed some light on some of the problems that exist in both the public and private sectors.

METHOD

The method used in this study is the functional approach. First, the structure of the seed market is elaborated. Then, the conduct of the participants in the public and private sectors is described. Finally, the performance of both the public and private sectors is evaluated.

To obtain the information necessary for analyzing the development of the seed industry in Thailand, two types of data have been gathered:

- **Secondary Data**
  Past studies and data about the seed industry have been collected and summarized.
- **Primary Data**
  In order to fully understand the industry's current status, interviews with the seed companies and government agencies involved in the industry have been conducted.

Both types of information have been summarized in order to provide a more complete picture of the seed industry in Thailand.

SCOPE OF THE STUDY

This study focuses on four major crop groups:

- rice;
- upland crops – corn, sorghum and mung beans;
- oil seed crops – soybeans and groundnuts;
- vegetables.

STRUCTURE

This first chapter provides the background of the study. The second chapter provides a description of the Thai economy and the role of the seed industry. The third chapter describes the structure of the public and private seed industries. The fourth chapter discusses the conduct of the public and private seed industries. The fifth chapter summarizes the performance of the industry, given its structure and conduct. And finally, the sixth chapter sets forth conclusions. The description of the research in plant breeding, the development of improved seed varieties and the structure of the survey are given in the Appendices.

Chapter 2

The Thai Economy and the Seed Industry

ECONOMIC PERFORMANCE

The Thai economy enjoyed steady growth throughout the past two decades in spite of many disruptions in the world economy. Compared with other developing countries, Thailand performed reasonably well during the vicissitudes of the 1970s and 1980s. The average rate of growth in Gross Domestic Product (GDP) was one of the highest among the ASEAN countries especially during 1980-1985 (see Table 2.1). In terms of sectoral growth, the Thai agricultural sector showed a slower growth rate than the industrial sector.

One important factor that allowed the economy to maintain this healthy level of development was the strength of Thailand's resource base, especially the abundance of fertile land. The increase in agricultural exports enabled the economy to maintain a rather fixed exchange rate, which led to a relatively low level of inflation and enhanced the growth of the nonagricultural sector.

The economy has slowly shifted away from agriculture over the past two decades. The agricultural sector's share in GDP declined steadily, while industry's share grew rapidly (Table 2.2). This trend will continue in the future because of the agricultural sector's much slower growth rate.

TRADE AND THE AGRICULTURAL SECTOR

Thailand has been a net exporter of agricultural products and a net importer of manufactured products. Some crops were grown solely for export, e.g., cassava and rubber. Food and processed food made up about 50 percent of the total export value (see Table 2.3). Although its share in total exports remained more or less constant over this period, there was a substantial change in its composition. The share of rice, the main export product, declined from about 14 percent during the 1950s to less than 9 percent during recent years, while the share of processed food increased dramatically.

Table 2.1 Average Annual Growth Rate (%)

Country	GDP 1965-1980	GDP 1980-1985	Agriculture 1965-1980	Agriculture 1980-1985	Industry 1965-1980	Industry 1980-1985	Services 1965-1980	Services 1980-1985
ASEAN:								
Thailand	7.4	5.1	4.9	3.7	9.5	5.1	8.0	6.0
Philippines	5.9	-0.5	4.6	1.7	8.0	-2.8	5.2	0.1
Indonesia	7.9	3.5	4.3	3.1	11.9	1.0	7.3	6.3
Malaysia	7.3	5.5	-	3.0	-	6.7	-	5.9
South Asia								
India	3.8	5.2	2.8	2.7	4.1	5.4	4.8	7.5
Pakistan	5.2	6.0	3.3	2.1	6.2	8.8	6.1	6.8
Bangladesh	2.4	3.6	1.5	2.8	3.8	4.7	3.4	4.3
Latin America								
Brazil	9.0	1.3	4.7	3.0	10.0	0.3	9.4	1.8
Argentina	3.3	-1.4	1.4	2.8	3.3	-2.5	3.9	-1.8
Chile	1.9	-1.1	1.6	2.1	0.8	-0.5	2.7	-2.1
Peru	3.9	-1.6	1.0	1.9	4.4	-3.0	4.3	-1.2
Africa								
Kenya	6.4	3.1	4.9	2.8	9.8	2.0	6.4	3.9
Tanzania	3.9	0.8	1.7	0.7	4.2	-4.5	6.7	2.8
Ghana	1.4	-0.7	1.6	-1.3	1.4	-5.5	1.1	2.2
Egypt	6.7	5.2	2.8	1.9	7.0	7.0	9.5	5.1

Source: World Bank, World Development Report, 1987.

Table 2.2 GDP Share of the Major Economic Sectors (%) (at Current Market Prices)

Year	Agriculture	Industry[a]	Services[b]
1960	39.76	18.55	41.70
1965	34.85	22.67	42.47
1970	28.29	25.33	46.38
1975	31.48	24.81	43.71
1980	25.38	28.49	46.13
1985	19.51	29.22	51.27

[a] Mining, manufacturing, construction, electricity and water supply.
[b] Transport and communications, wholesale and retail trade, banking, insurance and real estate, ownership of dwellings, public administration and defense.

Source: National Account Division, National Economic and Social Development Board.

Table 2.3 Structure of Exports, 1960-1985 (%)

Exports	1960-70	1970-80	1980-85
Food and processed food	50.8	50.1	49.2
Rice	29.3	15.1	14.3
Tapioca products	5.3	10.3	10.2
Sugar	0.6	6.0	4.5
Corn	9.9	7.4	5.2
Manufactured	9.6	28.0	36.4
Textiles and clothing	0.3	2.7	9.7
Precious stones	0.6	1.9	3.2
Integrated circuits	-	1.7	4.1
Others	39.6	21.9	14.4
Total	100.0	100.0	100.0

Source: Bank of Thailand Monthly Bulletin, various issues.

The ability to diversify the export of agricultural commodities enabled Thailand to maintain a steady growth in agricultural exports during the past two decades. Government policies contributed toward this diversification process by taxing exports of traditional agricultural commodities (such as rice and rubber), and the tax indirectly subsidized the production of other agricultural commodities. These indirect subsidies lowered the costs of producing other agricultural commodities and accelerated the diversification process.

THE AGRICULTURAL SECTOR AND CROP PRODUCTION

There are at least two factors that explain the steady growth of the agricultural sector in spite of its openness to the world market and fluctuations in world commodity prices:

1. Thailand has been able to diversify agricultural production to absorb changes in the world market.
2. Government policies tend to reduce the effects of world price changes on the domestic price. Siamwalla and Setboonsarng (1987) have shown that the government pricing policy has reduced the variation of domestic prices.

The ability to diversify production in the agricultural sector in the past provided this sector with a high degree of flexibility. But this is not obvious from an inspection of the value-added share of each component in the agricultural sector. The GDP share of crops, livestock, fishery and forestry changed only marginally over the past two decades. Table 2.4 shows that "crops" is the major component in the agricultural sector; its share remained at about 75 percent throughout this period.

Table 2.4 Value Added in Agriculture and Share of Each Component (%)

	Share in Agricultural Value Added			
	Crops	Livestock	Fishery	Forestry
1950-55	75.80	11.12	3.62	9.47
1955-60	75.91	12.72	3.33	8.04
1960-65	77.02	11.96	4.09	6.93
1965-70	74.87	11.02	7.54	6.58
1970-75	73.31	11.38	9.74	5.57
1975-80	73.38	12.08	9.78	4.77
1980-85	75.74	12.52	8.22	3.53

Source: National Account Division, National Economic and Social Development Board.

The more important changes took place within the crop and livestock sub-sectors. The composition of crops adjusted significantly in response to changes in the domestic and international markets. The share of rice has been declining, while the share of upland crops (such as corn, sugarcane and cassava) has been increasing. Since 1970 the share of corn has increased to about 10 percent, climbing up slightly to about 12 percent in 1985. The share of cassava has increased steadily from about 2 percent in 1970 to about 10 percent in 1985. These diversifications have enabled the crop sector to maintain its share in the agricultural sector. As for the livestock sector, the rapid expansion of poultry production played an important role in maintaining the share of the value of the livestock sector. The share of cattle has been declining, while the share of the dairy sector has grown (Setboonsarng, 1986).

CROP PRODUCTION AND LAND USE

Farmland comprises about 38 percent of Thailand's 51 million hectares. The rest of the land is forested (about 30%), national park area (about 5%) and unclassified (about 27%). The total cultivated area grew from about 7.5 million hectares in 1960 to about 14.6 million hectares in 1985, an average annual growth rate of about 3.4 percent (Table 2.5). This growth is unmatched by other Asian countries.

More than two-thirds of the cultivated area is planted with rice. There has been a slow increase in the rice area but the expansion of the cultivated area has been due mainly to the expansion of field crops. This expansion came in three waves: the expansion of corn production in the early 1950s and again in the early 1970s; the expansion of cassava in the late 1960s, which accelerated in the late 1970s; and finally, the expansion of sugarcane in the early 1970s, which accelerated in the late 1970s (see Table 2.5). One direct consequence of this growth in land use is a relatively low output per land area. However, in terms of output per worker, Thailand is among the highest in Asia. This pattern of growth cannot continue in the future because new land is no longer available for cultivation.

Table 2.5 Average Cultivated Areas of Major Crops

Year	Total (1000 ha)	Share (%) Rice	Corn	Cassava	Sugarcane	Soybeans	Other
1960-65	7,574	84.61	5.89	1.32	1.84	0.35	5.99
1965-70	9,029	79.81	7.91	1.55	1.29	0.53	8.91
1970-75	10,606	74.93	10.28	3.18	2.23	0.90	8.47
1975-80	13,039	70.88	10.41	6.63	3.65	0.98	7.44
1980-85	14,645	66.45	11.48	9.01	3.81	1.12	8.13

Source: Office of Agricultural Economics, Ministry of Agriculture and Cooperatives.

Since future development of the agricultural sector will not have the luxury of abundant land, the use of modern technology, especially higher-yielding seeds, will be an essential source of growth for the agricultural sector.

Another important characteristic of Thai agricultural production is its small farm size. The average farm size is about 1-3 hectares (Table 2.6). This small farm size suggests that income from crop cultivation is only one source of total household income; it serves as a subsistence activity for many farmers.

Table 2.6 Distribution of Land Holdings By Size of Holdings

Size Class (ha)	% of Holdings 1950	1963	1978	% of Land Area 1950	1963	1978
0.00 - 0.30	0.95	-	1.60	0.02	-	0.02
0.30 - 0.99	13.88	15.16	14.30	2.27	2.48	2.27
1.00 - 2.39	28.17	30.60	27.43	11.74	13.01	11.38
2.40 - 4.79	29.53	28.65	28.97	26.37	26.57	25.71
4.80 - 9.59	21.59	19.95	21.41	37.01	35.70	36.34
9.60 and over	5.88	5.64	6.29	22.59	22.24	24.28

Note: In the 1963 Agricultural Census, farms under 0.3 hectares were not enumerated.

Sources: Agricultural Census, 1950, Ministry of Agriculture;
Agricultural Censuses, 1963 and 1978, National Statistical Office, Office of the Prime Minister.

SEED REQUIREMENTS

The seed requirements can be calculated from planted areas and the amount of seed needed per land area for each crop. Rice requires the largest amount of seed. The total amount of seed for rice alone has averaged about 317,000 tons per annum during the past five years. Corn had the second highest requirement, but it used only about 50,000 tons (see Table 2.7).

Table 2.7 Seed Requirements (x 1,000 tons)

Crop	1981	1982	1983	1984	1985
Rice	299.85	300.67	312.98	311.65	317.1
Corn	39.18	41.98	42.21	45.42	49.5
Sorghum	5.25	4.60	4.97	5.51	5.8
Mung Beans	12.16	12.14	12.09	13.12	13.7
Soybeans	5.58	5.44	7.06	8.77	10.6
Groundnuts	15.28	15.23	15.66	16.14	15.5
Cotton	2.42	1.79	1.19	1.13	1.3

Note: The calculation of seed requirements is based on the following assumptions:

Rice	=	31.25 kg/ha
Corn	=	25 kg/ha
Sorghum	=	18.75 kg/ha
Mung Beans	=	2 kg/ha
Soybeans	=	43.75 kg/ha
Groundnuts	=	125 kg/ha
Cotton	=	15.625 kg/ha

Source: Based on planted area from Agricultural Statistics, Office of Agricultural Economics, 1986/7.

Farmers meet most of their seed requirements by retaining seed from the past harvest. This is particularly true for rice. The potential cash market was about 25 percent of the total seed need for major crops (Table 2.8). Most vegetable seed (about 50%), however, came from the cash market; sorghum and corn ranked second. A small portion of these seeds came from the public seed program; and an even smaller portion came from private seed companies. In 1986 the provision of seed by the government met only about 5 percent of total seed requirement (Table 2.9). The private sector was more active in the vegetable and corn markets.

Table 2.8 Field Crop and Vegetable Seed Situation in Thailand, 1986

Crop	Estimated Total Planting Area (ha)	Total Seed Need[a] (tons)	Estimated Annual Cash Market For Seed[b] Amount (tons)	% of Total Seed Needs
Rice	9,376,000	293,000	73,250	25
Corn	1,600,000	40,000	18,000	30
Sorghum	240,000	4,500	1,350	30
Mung Beans	448,000	11,200	2,800	25
Soybeans	208,000	13,000	3,300	25
Groundnuts	160,000	20,000	5,000	25
Cotton	160,000	3,000	750	25
Vegetables	125,000	1,900	950	50
Total	12,317,000	386,600	99,400	-

[a] Based on Department of Agricultural Extension recommended planting rates.
[b] Estimated by the Department of Agricultural Extension.

Source: Seed Division, Department of Agricultural Extension, 1986.

Table 2.9 Field Crop and Vegetable Seed Supply By Seed Division, 1986-1987

Crop	Seed Division Production Target: Amount (tons)		% of Total Seed Need		% of Cash Market for Seed	
	1986	*1987*	*1986*	*1987*	*1986*	*1987*
Rice	10,000	8,700	3.4	3.0	13.7	11.9
Corn	3,700	6,500	9.3	16.3	30.8	54.2
Sorghum	20	20	0.5	1.5	0.5	1.5
Mung Beans	1,000	1,360	8.9	12.1	35.7	48.6
Soybeans	2,500	4,300	19.2	33.1	75.8	130.3
Groundnuts	1,300	1,300	6.5	26.0	6.5	26.0
Cotton	400	280	13.3	9.3	53.3	37.3
Vegetables	3	7	0.2	0.4	0.3	0.7
Total	18,923	22,467	4.9	5.8	19.3	23.0

Source: Seed Division, Department of Agricultural Extension, 1986.

SEED TRADE

About 40 percent of imported seed is corn and sorghum. The import of sorghum (which is mostly hybrid seed) is the biggest item. The remaining 60 percent includes various kinds of vegetable seeds (Table 2.10).

Table 2.10 Import and Export of Seeds

Item	1983 Quantity in Tons	1983 Value in Mil. Baht	1984 Quantity in Tons	1984 Value in Mil. Baht	1985 Quantity in Tons	1985 Value in Mil. Baht
A. Imports[a]						
1 Green mustard	10	0.7	33	2.3	59	3.4
2 Chinese mustard	14	6.8	70	9.2	40	7.1
3 Radish	11	3.7	69	5.5	60	5.4
4 Morning glory	100	4.3	127	4.0	116	2.6
5 Chinese kale	34	2.0	150	6.8	139	7.7
6 Tomato	1	1.0	3	1.9	1	1.0
7 Chilli	1	0.4	1	0.5	-	-
8 Snow pea	61	0.8	104	1.7	46	1.4
9 Cucumber	-	-	-	-	-	-
10 Cauliflower	-	-	9	4.5	4	2.8
11 Cabbage	-	-	8	9.9	16	19.4
12 Cantonese mustard	-	-	70	2.4	40	1.7
13 Broccoli	-	-	-	-	2	0.7
14 Lettuce	-	-	3	0.7	1	0.1
15 Watermelon	-	-	21	4.6	18	4.8
16 Onion	-	-	2	1.9	4	4.2
17 Sweet corn	-	-	-	-	1	0.2
18 Corn	102	2.1	27	0.9	11	10.3
19 Sorghum	104	2.1	1,009	26.1	1,499	35.9
20 Soybeans	-	-	-	-	-	-
Total	438	23.9	1,706	83.7	2,058	108.9
B. Exports						
1 Cauliflower[a]	-	-	1.1	0.1	-	-
2 Chinese kale[a]	-	-	-	-	70.0	1.3
3 Cucumber[a]	-	-	1.2	0.1	-	-
4 Parsley[a]	-	-	-	-	5.0	0.2
5 Roselle[a]	-	-	0.1	0.0	-	-
6 Pumpkin[a]	-	-	0.1	0.0	53.0	1.0
7 Morning glory[a]	-	-	160.0	4.1	97.0	2.3
8 Watermelon[a]	-	-	4.0	0.4	7.0	0.8
9 Other	-	-	417.5	25.3	376.0	17.9
10 Vegetable seed for planting[b]	477.0	26.8	584.0	30.0	608.0	23.5
11 Seed for planting[b]	558.0	14.5	356.0	10.5	633.0	15.8
Total	1,035.0	41.3	940.0	40.5	1,241.0	39.2

Sources: [a] Seed Control Division, the Department of Agricultural Extension;
[b] Agricultural Statistics of Thailand, Crop Year 1985/86, Ministry of Agriculture and Cooperatives.

The Seed Law of 1964 requires importers to register with the Seed and Agricultural Control Subdivision of the Department of Agriculture (DOA). Importers are required to observe the quality standards stipulated in the Seed Law. The trend of seed import grew both in terms of quantity and value. It can be attributed largely to increased imports of sorghum and corn. With the reduction in the prices of sorghum and corn, imports of their seeds were reduced.

Thailand exports many kinds of vegetable seeds. The "other seeds" item is mostly tomato seed. The total value of vegetable seed exports has been around 40 million baht, with the net import value of seed increasing from about 43 million baht in 1984 to about 70 million baht in 1985.

GOVERNMENT POLICIES AND THE SEED MARKET

The government is involved in the seed industry in five main ways:

Provision of Foundation Seed

To support the seed industry, the DOA has invested in crop research, which provides the basis for the development of seed. Many research programs at the university level (e.g., the National Corn and Sorghum Research Center) also provide foundation seed for both the public and private sectors. Public provision of foundation seed plays a major role in the production of many seeds (e.g., rice, corn, soybeans and mung beans). Table 2.11 shows that the supply of foundation seed produced by the DOA has increased considerably since 1981. In 1983 the effort was concentrated on corn and groundnuts.

Most of the foundation seed is sold to the Seed Division for multiplication and distribution. The university research system also supplies some certified seed to farmers. However, these two public programs provide only a small proportion of the total seed requirement.

Table 2.11 The Production of Foundation Seed by the Department of Agriculture (in tons)

	1981	1982	1983	1984	1985	1986
Rice	532	532	532	532	532	532
Corn	N/A	43	71	110	110	108
Groundnuts	3	29	50	54	95	139
Cotton	-	5	20	20	20	20
Kenaf	19	19	15	15	15	10
Soybeans	-	51	10	90	90	92
Mung Beans	17	20	10	10	10	15
Sorghum	-	-	4	10	10	10
Sesame	1	-	0.5	2	2	2
Castor	-	0.5	1.5	3	3	2

Source: Seed Division, Department of Agricultural Extension, Ministry of Agriculture and Cooperatives, 1986.

Multiplication and Distribution of Improved Seed

Aside from providing the foundation seed, the government, through the Seed Division of the Department of Agricultural Extension (DOAE), multiplies and distributes certified seed to the farmer. The major crop that the Seed Division has focused its attention on is rice. During the mid-1970s and early 1980s, the quantity of maize seed has increased. And since the mid-1980s, soybean seed has also received increasing attention from the Seed Division. The distribution of this seed competes directly with the distribution of the private sector, particularly in the area of maize, where there are a lot of private companies. However, the government has been using the pricing of the publicly distributed seed as a means to regulate the price of seed in the private sector.

Quality Control

All companies trading (collecting, importing, exporting and distributing) have to register with the Seed Trade Control Subdivision, DOA. The trading of some seeds is subject to government regulation. The Seed Law of 1965 is the main legislation that governs seed quality. It provides quality standards for "controlled seeds" (e.g., vegetable seeds, corn and sorghum). Violation of the quality standard is grounds for losing one's seed-trading license.

In actual practice, the lack of personnel in the Seed Control Subdivision inhibits the monitoring of this law. Substandard seed is common in the market. Farmers are sometimes forced to use this substandard seed because they do not have any choice.

There is no seed certification in Thailand as yet. The only system close to certification is the procedure for releasing the publicly recommended crop varieties of the DOA. A release procedure entails a series of tests that confirm the result of its yield across regions.

Investment Privileges

The seed industry is among the industries that receive promotional privileges from the Board of Investment (BOI). The privileges include an exemption from the import duty for machinery, a five-year tax holiday and the hiring of foreign experts. While these privileges are aimed at attracting foreign investors, most Thai seed companies do not benefit from the investment privileges.

Export and Import Control

Aside from the sales and municipal taxes, imported seed is subject to a 5 percent import tariff. There is no export tax for the export of seed. However, the import of onion seed is subject to a control by the Marketing Organization for Farmers (MOF). MOF is the sole importer and distributor of onion seed. The objective of this control is to regulate the supply of onions. All onion farmers have to register with the MOF, and the quantity of seed sold to each farmer is proportionate to the share of the total planned output determined by the Office of Agricultural Economics.

There is no legal protection for new plant varieties in Thailand. Currently, there is pressure for a plant variety law in Thailand. However, given the lack of competent personnel, its enforcement would be difficult.

There is also no seed certification system in Thailand. The Seed Law only provides the quality standards for controlled seeds. Seed sold on the market does not have to be certified. Producers themselves are responsible for ensuring the quality of their seed.

In summary, in an agricultural-based economy such as Thailand, sound development of the seed industry is important for the growth of both the agricultural sector and the entire economy. Most of the seed used is open-pollinated – that is, retained by farmers from previous harvests. The public seed program supplies only a limited quantity of the total demand. Some of the seed, such as vegetable and hybrid seeds, is imported. The government has laid down some rules to regulate the seed market such as licensing of seed companies and quality standards. On the basis of the above background information, the structure, conduct and performance of the seed industry will now be discussed.

Chapter 3

Structure of the Seed Industry

Both the private and the public sectors carry out the production and distribution of improved seed. This section discusses the structure of these two participants.

ORGANIZATION OF IMPROVED SEED IN THE PUBLIC SECTOR

The National Seed Program, created in 1976 to coordinate the activities of various government agencies involved in the production and distribution of seed, has the following targets:

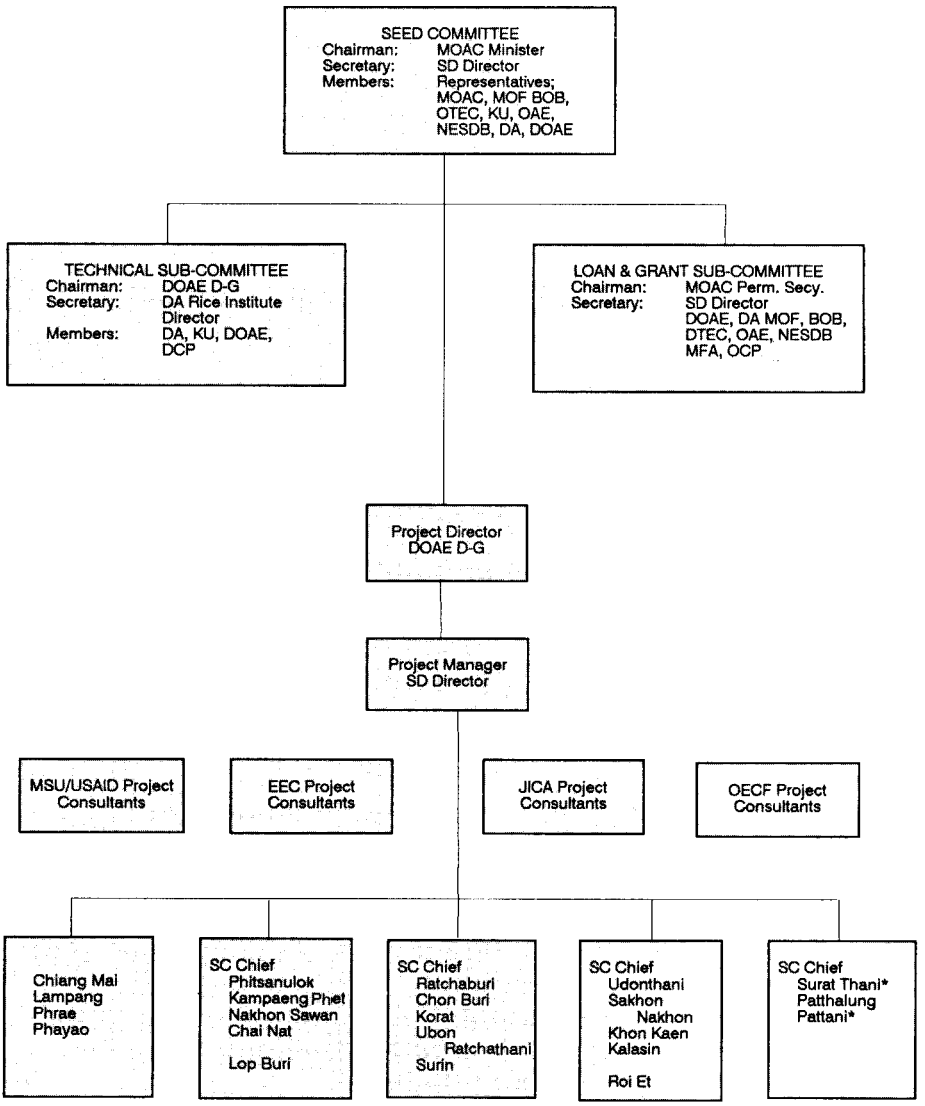
- to promote the use of high-quality seed that will increase farm productivity and farmers' incomes;
- to multiply high-quality seed developed by the DOA and other research institutions;
- to encourage farmers, agricultural institutions and the private sector to produce high-quality seed for distribution in both domestic and foreign markets.

To achieve these objectives, the National Seed Program carries out many activities, including the development of improved crop varieties, the production of foundation seed, the supply of legume inoculators, the multiplication of improved seed, drying and processing, marketing and distribution of seed, and farmer training and education. The National Seed Committee (NSC) was created to carry out the tasks established by the National Seed Program.

The NSC is chaired by the Minister of Agriculture and Cooperatives. Members of the committee come from related government agencies such as the Ministry of Agriculture and Cooperatives, the Ministry of Finance, Bureau of the Budget, the Department of Technical and Economic Cooperation and Kasetsart University (see Figure 3.1). There are two major subcommittees for technical and financial problems under this committee. In practice, the more important task of the Seed Committee is to search for and manage financial support for seed development by the public sector.

On the operations side, the Director General of the DOAE is the Director of the NSC. The actual production of seed is the assignment of the Seed Division of the DOAE.

The organizational structure of the Seed Development Project is given in Figure 3.2. Breeder and foundation seeds are maintained and produced by the DOA. The Seed Division of the DOAE obtains foundation seed from the DOA and distributes



Note:
MOAC Ministry of Agriculture and Cooperatives
MOF Ministry of Finance
NESDB National Economic and Social Development Board
DTEC Department of Technical and Economic Cooperation
DOAE Department of Agricultural Extension
SC Seed Center
SD Seed Division
BOB Bureau of the Budget
KU Kasetsart University
OAE Office of Agricultural Economics
DA Department of Agriculture
DCP Department of Cooperative Promotion
MFA Ministry of Foreign Affairs
* Not yet Constructed

Figure 3.1 Organization and Administration of Seed Development Project

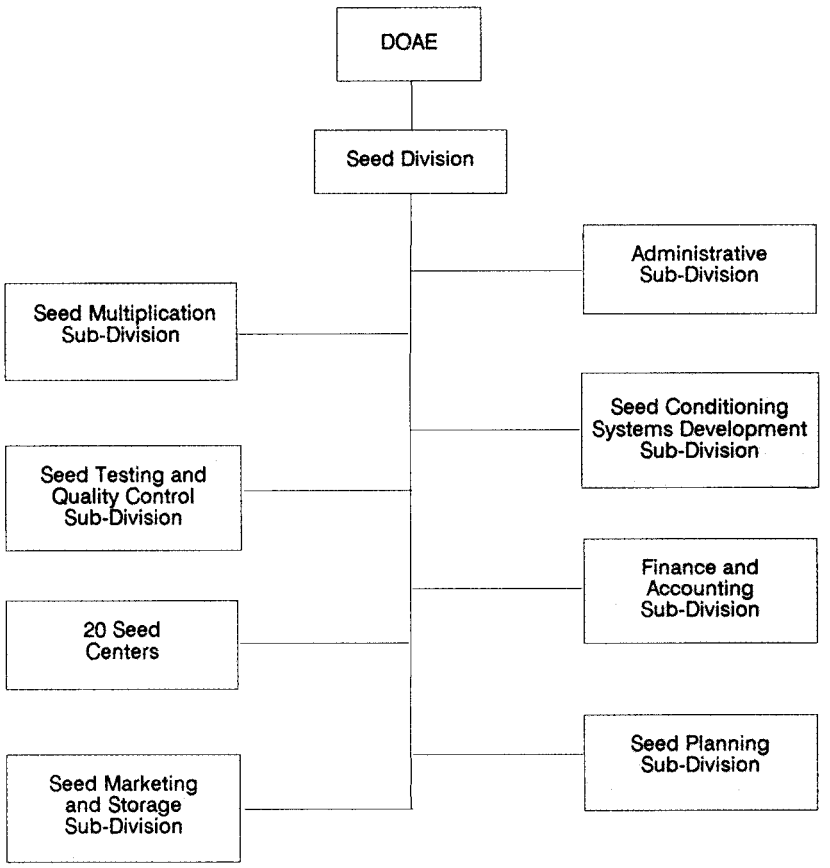


Figure 3.2 Organization Chart of Seed Division

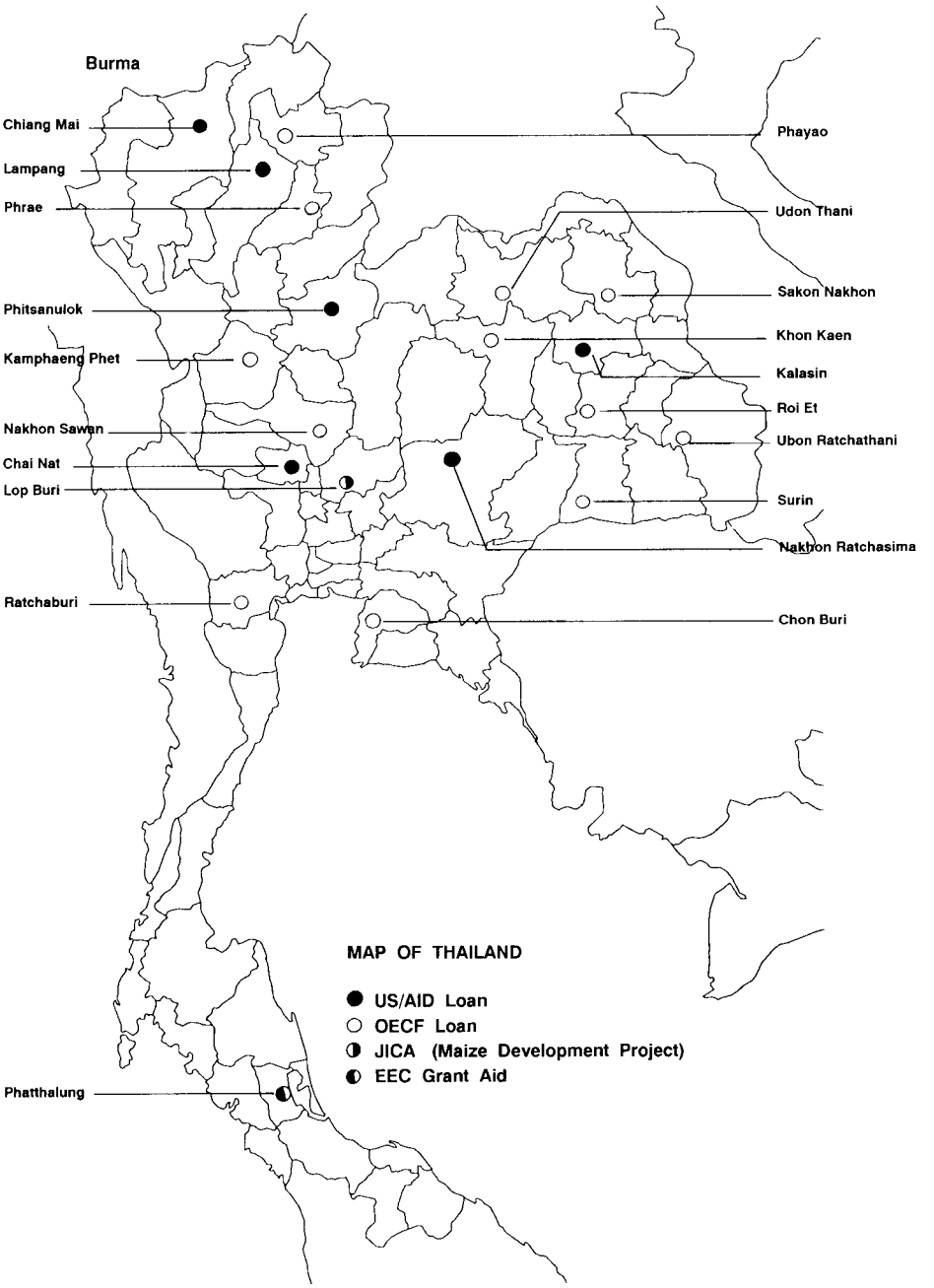
it to appropriate seed (multiplication) centers throughout the country. Each of the centers selects its contract farmers to grow the seed. The seed centers buy back these seeds at a price of about 10 percent above the market price of grain. These seeds are processed and kept in storage, ready for distribution.

After the first seed center was built in 1975, the number of seed centers increased rapidly. At present, there are 20 seed centers located throughout Thailand. The list of these centers and the types of seed produced are given in table 3.1. Figure 3.3 shows their location. The first four seed centers (Seed Centers Nos. 1 to 4), were established under the initial six-year loan project from the United States Agency for International Development (USAID). They are at Phitsanulok, Nakhon Ratchasima, Lampang and Chai Nat, respectively. These four centers are responsible for producing rice, corn, sorghum, soybean, mung bean, groundnut and cotton seed.

Table 3.1 Seed Centers of the Seed Division in 1986 and Sources of Funds

Seed Center Number	Location (province)	Sources of Funds (International Agency)	Improved Seed to Be Produced (Crops)
1	Phitsanulok	USAID (phase I)	Rice, Corn, Mung Beans, Soybeans
2	Nakhon Ratchasima	USAID (phase I)	Rice, Corn, Sorghum, Groundnuts
3	Lampang	USAID (phase I)	Rice, Soybeans, Groundnuts
4	Chai Nat	USAID (phase I)	Rice, Corn, Mung Beans, Cotton, Sorghum
5	Lop Buri	JICA	Rice, Corn, Cotton
6	Phatthalung	EEC	Rice , Groundnuts, Mung Beans
7	Chiang Mai	USAID (phase II)	Vegetables, Rice, Soybeans, Groundnuts
8	Phayao	OECF	Rice, Soybeans, Groundnuts
9	Kamphaeng Phet	OECF	Rice, Groundnuts, Soybeans
10	Ubon Ratchathani	OECF	Rice, Groundnuts, Soybeans
11	Roi Et	OECF	Rice, Groundnuts, Soybeans
12	Udon Thani	OECF	Rice, Groundnuts, Soybeans
13	Kalasin	USAID (phase II)	Rice, Groundnuts, Soybeans
14	Phrae	OECF	Rice, Soybeans, Mung Beans
15	Nakhon Sawan	OECF	Rice, Soybeans, Mung Beans
16	Surin	OECF	Rice, Groundnuts
17	Khon Kaen	OECF	Rice, Groundnuts
18	Sakon Nakhon	OECF	Rice, Groundnuts
19	Chon Buri	OECF	Rice, Soybeans, Mung Beans
20	Ratchaburi	OECF	Rice, Soybeans, Mung Beans

Source: Seed Division, Department of Agricultural Extension, Ministry of Agriculture and Cooperatives, 1987.



Source: Seed Division, Department of Agricultural Extension, Ministry of Agriculture and Cooperatives, 1987.

Figure 3.3 Seed Centers in Thailand

The National Seed Committee has received a great deal of financial support (loans) from international funding agencies. Besides the loan from USAID, other international agencies that provide funds are: the Japanese International Cooperation Agency (JICA), which helped to establish Seed Center No. 5 for corn at Lop Buri in 1978 under the Corn Development Project in Thailand of the Columbo Plan, 1976-1984; the European Economic Community (EEC), which helped to establish Seed Center No. 6 in Phatthalung in the South in 1983; and the Overseas Economic Cooperation Fund (OECF), which financed 12 more seed centers during 1983-1986. The latest USAID Phase II loan financed two additional seed centers – at Chiang Mai in 1983 and at Kalasin in 1984.

Construction of the Centers was completed in 1986, but some of them are not yet operating because the Civil Service Commission has to see a fully built plant before it can approve the hiring of personnel.

Despite many obstacles, the Seed Division's output has rapidly expanded. Its total output increased from a little over 8,000 tons in 1983 to 14,000 tons in 1987, an increase of about 75 percent in four years (see Table 3.2).

Table 3.2 also shows that 60 percent of the total seed produced by the Seed Division is for rice. Corn is second in importance. Corn seed production was highest in 1984 (2,700 tons). Since then, the output has been declining due to the lower demand for corn seed induced by the decline in the price of the corn.

Besides the Seed Division, the National Corn and Sorghum Research Center (NCSRC) of Kasetsart University at Suwan Farm also produces and sells improved corn and sorghum seed (Table 3.3). The major part of the NCSRC's production is in the open-pollinated Suwan 1 seed. A limited quantity of hybrid corn seed is produced more for educational than for commercial purposes. Apart from commercial seed production, the NCSRC also serves as the supplier of corn and sorghum breeder and foundation seed to the Seed Division and to private seed companies. The NCSRC also sold some inbred lines to private companies.

Table 3.2 Improved Seed Produced by the Seed Division (in tons)

Crop	1983	1984	1985	1986	1987
Rice	3,893	3,776	3,787	4,706	8,425
Corn	2,511	2,706	2,619	2,493	2,097
Soybeans	968	800	666	1,448	1,507
Groundnuts	311	619	164	357	1,187
Mung Beans	464	431	369	586	878
Cotton	69	142	6	198	12
Sorghum	33	14	14	21	4
Kenaf	-	-	-	2	5
Wheat	-	-	-	-	16
Sesame	-	-	-	-	0.3
Total	8,248	8,489	7,625	9,811	14,138

Source: Seed Division, Department of Agricultural Extension, Ministry of Agriculture and Cooperatives, 1987.

Table 3.3 Production of Seed by the National Corn and Sorghum Research Center, Kasetsart University, 1982-1986 (in tons)

Crop	1982	1983	1984	1985	1986	1987
Corn:						
Suwan 1	233.0	365.0	479.0	303.0	300.0	128
Suwan 2	71.0	48.0	34.0	106.0	80.0	111
Hybrid:						
KSX 2301	1.9	45.0	16.0	55.0	10.0	-
KTX 2602	-	-	-	65.0	20.0	4.0
Super Sweet	2.3	5.0	4.5	9.5	10.0	77.0
Sorghum:						
K.U. 439	-	5.6	-	58.0	-	-
Hybrid:						
K.U. 8501	-	-	-	-	2.0	-

Source: National Sorghum and Corn Research Center, Kasetsart University, 1987.

Soybeans are the third most important item. Production has been increasing rapidly (particularly since 1985), because government intervention in the import of soybeans and soybean meal pushed up the domestic price. The promotion of soybean cultivation and the use of soybean seed for the drought relief program also helped increase soybean seed production by the Seed Division, especially in 1987.

The production of groundnut seed fluctuates greatly because of weather damage. The demand for groundnuts has also rapidly increased during the past few years, especially for direct consumption and export. The international demand played a major role in pushing up its domestic price. Further, expansion of production increased the demand for groundnut seed. Groundnut seed is also used in the public drought relief program. The 1986-1987 drought significantly increased the demand for groundnut seed.

Mung bean seed is another item used by the public drought relief program; therefore, its demand has also risen during the past few years. Small quantities of cotton and sorghum seed are also produced by the Seed Division. Some new items were recently added to the list (e.g., wheat and sesame seeds.) However, almost all the Seed Division's efforts are concentrated on the first five crops described above.

The production of vegetable seed by the Seed Division is still in an early stage of development. The Seed Division has obtained the equipment necessary for processing vegetable seed (at Seed Center No. 7), but due to lack of personnel, only some of the equipment has been actively used. When it does operate at full capacity, it will be able to process most of the vegetable seed needed in Thailand.

STRUCTURE OF THE PRIVATE SEED INDUSTRY

Our studies of the registered seed companies in 1984-1985 indicate that most companies are registered to collect and import seed (Table 3.4). They are also concentrating on the vegetable and corn seed business.[1] In fact, many companies are concerned with both vegetable and field crops, indicating that they are not specializing.

Table 3.4 Number and Percentage of Seed Companies, Classified By Activity, 1987

Seed	Collecting		Importing		Exporting	
	No.	(%)	No.	(%)	No.	(%)
Vegetables	31	23.8	23	43.4	13	38.2
Corn	29	22.3	4	7.5	5	14.7
Field Crops	14	10.8	2	3.8	2	5.9
Rice	2	1.5	-	-	-	-
Tomatoes	2	1.5	-	-	-	-
Corn and Other Field Crops	7	5.4	3	5.7	5	14.7
Vegetables and Corn	14	10.8	6	11.3	4	11.8
Vegetables and Other Field Crops	15	11.5	2	3.8	2	5.9
Other	16	12.3	13	24.5	3	8.8
Total	130	100.0	53	100.0	34	100.0

Notes: The Marketing Organization for Farmers, also a registered collector and importer of seed, is not counted as a private company here.
There are two or three companies that are subsidiaries of other companies. They are nonetheless counted separately here.

Source: Agricultural Regulatory Division, Department of Agriculture.

An interesting point to note here is the relatively larger number of seed companies; this suggests that entry into this industry is not difficult. And the government has a relatively open policy as far as foreign investment in this industry is concerned. Many seed companies have acquired BOI promotional privileges,

1 They are also very active in the area of ornamental plants such as orchids. Since this study focuses only on food crops, these non-food crop activities are not included in this study.

especially for export production. However, the number of companies does not reflect the degree of competition in the industry because each seed market is dominated by a few companies. Their domination is based on their relatively higher degree of technical sophistication in marketing and/or in production.

The domination of private activity in the vegetable market arose from the fact that each vegetable seed market is small and not economical enough to justify public research. A vast number of vegetable seed varieties are imported; therefore, private companies are in control of the vegetable seed business.

To date, domestic production technology has advanced slowly. Private research and development in plant breeding for both hybrid and open-pollinated vegetable varieties has been active only in the past decade. This slow development in production technology occurred partly because of the small size of the domestic market and partly due to the low price of imported seed. Recent developments in production technology have been stimulated by the entry of foreign seed companies. This stimulation sent off wide repercussions not only in the vegetable seed industry but also in other seed-related businesses.

A new activity in the seed industry is custom seed production, especially for hybrid seeds. The custom production of hybrid seed for both import and export has been expanding. For example, the production and export of hybrid tomato seed went up from four tons in 1985 to six tons in 1986. Further, custom seed production services in foreign countries have been used to produce vegetable seeds that are suitable for Thailand (e.g., tomato seeds).

Companies also sell seed for field crops. The introduction of Suwan 1, an improved corn variety released by the NCSRC in 1975, marked the beginning of the era of modern, private, corn seed companies. Many international companies started operating in Thailand around that time.

To promote private-sector activity, a Seed Club was established in the early 1980s, initiated by the Seed Division of the DOAE. Field crop companies were active participants in the Seed Club. Vegetable seed companies, which form a larger group, were less active. The fall in the international corn price reduced the size of the corn seed market in 1984, and the number of corn seed companies shrank. Since then, the Seed Club has become rather inactive.

Private seed companies can be broadly divided into three groups. The first group of companies is involved in the full set of seed activities, namely, plant breeding, seed selection, production, seed processing, storage and marketing. Their distribution networks are well established throughout the country. These companies also have close linkages with the international market. The second group of seed companies selects different seed varieties for development and focuses on the domestic market. The third group is comprised of local seed companies involved in seed multiplication and marketing, mostly for the market in their own localities (see Table 3.5).

Companies in the first group have been established much longer and have more permanent employees (Table 3.5). The third group consists of smaller companies that go in and out of the seed market when appropriate. While they are more flexible in the short run, they cannot be competitive in the long run because they have not made any long-term investments, especially in research.

Table 3.5 Number of Years in Business and Number of Employees of the Major Groups of Seed Companies

Major Groups of Seed Companies	Number of Years in Seed Business	Number of Employees	
		permanent (range)	temporary (range)
Group A	10-60	55	50
Group B	2-5	15 (20-117)	9 (10-70)
Group C	1-2	3 (0-6)	6 (5-7)

The structure of four different seed markets are described below to illustrate their differences.

Basmati Rice

Almost all rice seed is seed saved by farmers from previous harvests. However, for some specific varieties, seed has to be purchased each season. An example is Basmati rice. The aromatic Basmati rice seed was brought in from Pakistan and India to be grown by contracted farmers in the northern part of Thailand (see the discussion of the development of Basmati rice in Appendix B).

Currently, there are four companies involved in Basmati rice:

- Siam Mati Co., Ltd (1978).
- Asian Chemical Fertilizer Industry Company (1983).
- Khao Chaiya Porn (1984).
- Chiangmai Chaiwiwat Ricemill Co., Ltd (1986).

The year in brackets indicates the year in which the company started its Basmati rice activities. Siam Mati, a joint venture with an Indian company, pioneered this effort by importing the open-pollinated non-photoperiod-sensitive Basmati 370 rice variety from India. The Asian Chemical Fertilizer Industry Company, however, imported the Basmati seed from Pakistan. The last two companies that came to be involved in Basmati are Thai rice millers; the fourth company, which began in 1986, has expanded more rapidly than the others.

In 1986 less than 40,000 rai (6,400 hectares) was planted with Basmati. Now, however, many government agencies are assisting in the expansion of Basmati rice through the contract farming process. For example, the DOAE aided the above companies by providing them with information on the cultivation of this crop, and the Bank of Agriculture and Cooperatives provided the credit needed for production. It is estimated that by 1988 the planted area was as much as 150,000 rai (24,000 hectares).

One lesson to be drawn from the Basmati rice experience is that there is little to be gained by pioneering in an open-pollinated crop, because entry cannot be prevented, and, consequently, monopoly rent cannot be captured.

Corn

The private sector became actively involved in the corn seed business in the mid-1970s, especially after the release of the improved variety Suwan 1 (see the development of corn seed in Appendix C). The total amount of seed sold by the private sector expanded rapidly during the first half of the 1980s, but has declined since 1985 because of the low price of the grain. Most of the seed sold by private companies is Suwan 1.

There are six companies that produce and sell hybrid corn seed. They also engage in other field crops like sorghum and sunflower seed (Table 3.6). These companies are classified as Group A companies. Five of the six major companies are subsidiaries of or joint ventures with international seed companies (Table 3.7). This foreign connection allows them access to foreign technology and capital. The smallest company in this category is a Thai company that joined the industry in 1982.

There are also a large number of medium- and small-sized companies that sell only open-pollinated corn seed. These companies operate in a rather informal way, and their actual sales volume is therefore difficult to assess.

Table 3.6 Year of Establishment, Registered Capital and Crops of the Major Field Crop Companies in Thailand

Company	Year Established	Reg. capital (million baht)	Crops		
			Corn	Sorghum	Sunflower
Pacific Seed	1978	20	/	/	/
Ciba-Geigy	1981	20	/	/	/
Charoen Phokhaphan	1978	30	/	/	/
Pioneer	1980	10	/	/	/
Cargill	1979	-	/	/	/
Thai Seeds	1982	2-5	/	/	/

Source: Sukasem Chitsingh, "Production and Market of Field Crop Seeds by Private Companies." Paper presented at the Seminar on Seed Production Development, Regent Marina Hotel, Pattaya, Chon Buri, January 6-8, 1988, organized by the Seed Division of the Department of Agricultural Extension.

Table 3.7 Foreign Partners of Major Field Crop Seed Companies

Company	Foreign Partner	Type of Venture
1. Pacific Seed	Continental Grain	Subsidiary
2. Ciba-Geigy	Ciba-Geigy	Subsidiary
3. Bangkok Seed (a CP Group company)	Dekalb	Joint venture
4. Pioneer Hybrid (Thailand) Co.	Pioneer International	Subsidiary
5. Cargill Seed	Cargill	Subsidiary

Source: Survey by authors.

Vegetables

The vegetable seed market is different from the markets for rice seeds and field crop seeds because the market for each vegetable seed is smaller than that for cereal seeds. On the other hand, the cost of vegetable seed (by weight) is very high because the production costs are high and its output value is also high. The limited size of the vegetable market means that it can only accommodate a few producers. However, its high price leaves much room for research to cut down production costs. These two factors determine the structure of the market for vegetable seed not only in Thailand but also around the world.

One particular characteristic of the vegetable market is that there is a great deal of trade. This feature can be explained by the fact that only a few companies can invest in research in a particular vegetable seed. Therefore, there is a high degree of specialization in vegetable seed production. This specialization makes it possible for these companies to compete with local producers of seed in other countries. The number of hybrid vegetable seeds on the world market is probably greater than for any other type of crop.

It was estimated that the total value of vegetable seed sales in Thailand was about 150-200 million baht in 1985 and that open-pollinated vegetable seed accounted for approximately 60 percent of the seed in 1985 (Groosman 1988).

Of the approximately 129 seed companies licensed to handle vegetable seed, e.g., as collectors and/or importers and/or exporters (see Table 3.8), only 78 companies are solely vegetable seed companies. A large proportion of these companies collect from and sell to the domestic market. Those who collect from the domestic market and also import part of their output rank second. Companies that collect and export are smaller in number when compared with the first and second types.

An increase in the number of vegetable seed companies during the past decade indicates some degree of price competition. However, it is highly concentrated. The industry is dominated by only a few companies. Interview results indicate that six major companies hold about 90 percent of the domestic vegetable seed market: Chiatai, Chia Kwang Seng, Tia Seng Heng Huat, East-West Seed, Num Tai Chiang, and Chua Yong Seng companies. Only the first four have an experimental station.

Table 3.8 Types of Registered Vegetable Seed Companies, 1984-1985

Activity	No. of Companies	Vegetable seed			
		Veg.Only	(%)	Veg. + Other	(%)
Collecting only	90	31	34	62	69
Collecting and import	40	23	58	31	78
Collecting and export	29	13	45	21	72
Collecting and import and export	24	11	45	15	63

Source: Calculated from the List of Licensed Seed Collectors, Importers and Exporters, 1984-1985, Seed Subdivision, Division of Plant and Agricultural Materials Control, Department of Agriculture, Ministry of Agriculture and Cooperatives.

Chiatai is the largest and one of the oldest vegetable seed companies in Thailand. The company shares about 60 percent of the domestic vegetable seed market. Most of its products are imported. The research and breeding activities of the company have just started recently.

East-West Seed is one of the newest seed companies. It is a BOI-promoted company with capital and technology from the Netherlands. The entry of East-West Seed into the seed industry in Thailand in 1985 greatly stimulated interest in carrying out research and breeding of vegetable seed in Thailand, especially for the domestic market.

Chia Kwang Seng and Tia Seng Heng Huat are well established companies. They import seed and use some as multiply seed.

There are many smaller seed companies that specialize in particular crops for particular localities. Most of these smaller companies do not use sophisticated production techniques.

Custom Seed Production

Custom seed production is mostly for export. Some imported seeds are produced to a particular Thai company's specifications, especially companies with their own experimental stations.

There are at least seven custom seed production companies that produce seed for export: Asgrow (Thailand) Co., Adam International, Universal Agriculture Co., TSA Co., Universal Seed Co., Known-you Seed, and Thevaporn Thai Agriculture Co. These companies are medium sized and are either subsidiaries of international companies or joint ventures with foreign partners (see Table 3.9). Except for Known-you Seed (which specializes in hybrid melon seeds), other companies concentrate on producing hybrid tomato seed.

The private seed company activities will be described in the next section.

Table 3.9 Custom Seed Production Companies

Company	Foreign Affiliation
1. Asgrow Seed	Subsidiary of Asgrow (U.S.A.)
2. Adam International	Selling to Peto Seed (U.S.A.)
3. Universal Seed Co.	Asgrow Seed, and Asgrow (U.S.A.)
4. T.S.A.	Selling to Sluis and Groot (Netherlands)
5. Devaporn Agriculture	Partnership with Sluis and Groot
6. Universal Agriculture	Subsidiary of Adam International
7. Know-you Seed	Know-you Seed (Taiwan)

Source: Survey by authors.

Chapter 4

Conduct of the Seed Industry

The objective of the public agencies involved in the seed market is to provide quality seed for farmers (Seed Division 1987). These written objectives can be evaluated by studying actual agency operations and conduct. The objective of the private sector is to maximize profits. It is the government's concern to see to it that they do not harm others in their pursuit of profit.

The discussion of the conduct of the seed market is divided into two parts: the public sector and the private sector. Their behavior will be elaborated in terms of the following topics:

- production policy and technology;
- distribution and sales strategy; and
- price determination.

CONDUCT OF THE PUBLIC SEED SECTOR

Production of Improved Seeds

The most important public agency in seed production is the Seed Division of the Department of Agricultural Extension (DOAE) in the Ministry of Agriculture and Cooperatives (MOAC). The Seed Division's target is to supply about 5 percent of the total seed needs of major crops. However, current production is still below this target (see Table 4.1) because some seed centers are not yet fully operational.

Private seed companies are increasingly concerned that when these seed centers are fully operational, they will have a negative impact on them. To put these concerns to rest, the Seed Division has to clarify its role. It is essential that the division's objective – to enhance sound development of the private seed sector – be translated into consistent action.

One interesting fact to be noted here is that almost all seeds that the Seed Division produces are open-pollinated. A negligible quantity of hybrid corn seed is sold by the public seed program.

Table 4.1 Share of Seeds Produced by the Seed Division, 1987

Crops	Total Seed Requirement (tons)	Percentage of Total		
		Cash Market[1]	Target[1]	Actual
Rice	307,850	25	3.0	2.7
Corn	48,770	30	16.3	4.3
Soybeans	12,590	90	33.1	12.0
Groundnuts	15,800	25	26.0	7.5
Mung beans	12,690	25	12.1	6.9
Cotton	790	25	9.3	1.6
Sorghum	3,640	30	1.5	0.1
Vegetable	4,315	-	0.5	-

[1] Based on the Seed Division, 1986.

Source: Seed Division, Department of Agricultural Extension, Ministry of Agriculture and Cooperatives, 1988.

The Public Sector's Distribution of Improved Seed

The public sector's distribution of improved seed is shown in Figure 4.1 and Table 4.2. In 1987 about 90 percent of the total quantity of improved seed distributed by the Seed Division went to government-supported projects such as the Rice Seed Exchange Program, the Rice Promotion in Rainfed Areas Program, the Cassava Replacement Program and the Natural Disaster and Emergency Relief Program. This seed will eventually reach farmers at a highly subsidized price. Less than 10 percent of the seed from the Seed Division went directly to the farmer. This distribution system reflects the fact that the seed program is more an emergency relief activity than a commercial enterprise.

The pattern is true for the five major crops: rice, corn, soybeans, groundnuts and mung beans (see Table 4.2). However, it does not apply to fiber crops (cotton and kenaf), where about 57 and 99 percent of the seed, respectively, went directly to the farmer.

The distribution of vegetable seed has its own characteristics. Most of the output (about 99%) went to other government agencies.

Most of the improved corn and sorghum seed produced by the National Corn and Sorghum Research Center of Kasetsart University was sold to individual farmers and Farmers' Cooperatives throughout the corn- and sorghum-growing areas.

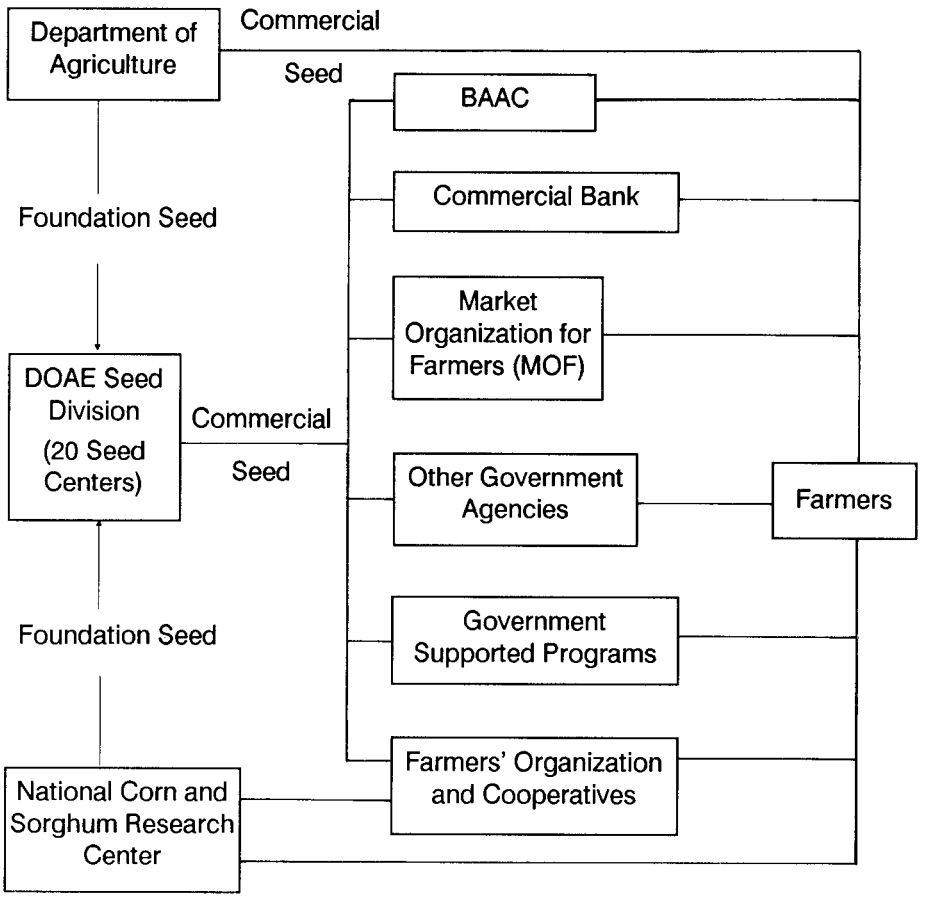


Figure 4.1 Distribution of Seed from the Public Sector

Price Determination

For the farmer, the price of seed in the public seed exchange program is usually very low; in fact, seed under the drought relief program is free. In the improved rice seed program, the farmer's grain is exchanged for the improved seed. Only a small amount of the seed the public sector produces is sold to the farmer at market prices. Therefore, the public seed program is a subsidy program.

However, to facilitate planning and budgeting, there is an internal pricing system that indicates the value of resources transferred between the different government agencies involved in producing and distributing seed.

The two main government agency groups, the Seed Division and the universities, have very different pricing methods. The price the Seed Division charges other government agencies is based on the average cost of production and the Seed Division has its operating costs paid from the budget.

Table 4.2 Distribution of Seeds by the Seed Division, 1987

Crops	Total (tons)	Share (percent) Special Program	Farmer	Government Agencies	Middleman
Rice	9,965.1	90.5	1.4	6.4	1.7
Corn	1,856.4	84.6	9.8	4.1	1.5
Soybeans	2,456.3	93.4	2.8	3.8	-
Groundnuts	1,104.3	90.9	5.7	3.4	-
Mung Beans	875.7	82.3	4.5	13.2	-
Cotton	36.4	-	56.6	42.6	1.8
Sorghum	4.5	-	8.9	91.1	-
Kenaf	1.8	-	98.9	1.1	-
Sesame	0.5	-	100.0	-	-
Vegetables	14.4	-	1.4	98.6	-
Total	15,311.1	88.9	3.3	6.5	1.3

Source: Seed Division, Department of Agricultural Extension, Ministry of Agriculture and Cooperatives. 1988.

CONDUCT OF THE PRIVATE SEED SECTOR

Competition in the private seed business has become keener in recent years, as the number of companies in this business has increased. While most of the seed companies in Thailand are in their first phase of development (see the previous section on the structure of the private seed industry) and some are in the second phase, no Thai company is in the third phase of development. The custom production of hybrid seed for export reflects the specialization of other countries.

The conduct of the seed companies for the main crops varies greatly. Both technical and economic constraints are important determinants of their behavior.

Rice

Private companies in the imported rice seed market develop and distribute the seed for their contract farmers and buy back all the Basmati rice produced. They do not buy rice from farmers on contract because it is difficult to monitor the quality of their rice. The price offered to the contract farmer is based on the world market price because nearly all the Basmati produced is exported.

The foreign market is not a constraint on this premium grade of rice. The Basmati rice grown in Thailand is not high quality; there is still ample demand at the lower end of the Basmati market. This product differentiation allows the Thai Basmati to penetrate the world Basmati market.

While the Basmati rice companies have their own experimental plots, their degree of sophistication varies. Investment in research is small, however, because the key factor in competition is not the quality of the seed. The costs of research to upgrade its quality are great, especially from the private sector's point of view.

Investment in this open-pollinated crop does not allow a private company to capture the return on research.

The most important factor in the expansion of Basmati rice cultivation is the number of reliable contract farmers. The competition in attracting good farmers has increased the farmgate price for those farmers. Since the quality of rice is crucial here and monitoring quality is very costly, it is critical for the success in this business to provide the right incentive to the right farmer.

As is the case with the adoption of other agricultural technology, training and selecting good farmers is a necessary but slow process in developing the Basmati market. It takes many cropping seasons to get to know the farmer. Farmers, rather than the total planted area, are the key to the industry's development. At the same time, competition in the Basmati market involves expansion of the planted area. The rapid expansion of the Basmati area, planned by the private companies and supported by the public sector, could bring about variation in quality, because farmers might not have adequate skills to cultivate this crop in a short period of time.

Corn and Sorghum Seed

The private sector's role is highly visible in the corn and sorghum seed markets. Competition among private companies is quite active, both in the open-pollinated and the hybrid markets. Therefore, the marketing conduct of these private companies should be carefully investigated.

Price determination

In a perfectly competitive market, the seed price is determined by the costs of production, which vary from company to company. These costs include the cost of seed purchased from the contract farmers, which may not differ greatly among companies, and the cost of processing or conditioning, which varies from company to company because of differences in fixed costs, such as capital investment and research costs. Large companies usually have higher fixed costs because of the higher costs of investment in research and development, while smaller companies have lower investment costs. However, small companies are not capable of producing hybrid seed because it is not economical to maintain adequate research facilities, with the associated technicians performing inbred line research. Thus, price determination differs between the open-pollinated and hybrid seeds.

For the open-pollinated corn and sorghum seed, the production process is simple, and a small amount of investment in needed. Small companies can easily enter into the market by purchasing foundation seed from the public sector, especially from Kasetsart University, and multiplying this seed using contract farmers. The ease of entry leads to a high degree of competition in the open-pollinated seed market. The price of open-pollinated seed therefore reflects the marginal cost of production.

For the pricing of hybrid corn and sorghum seed, the private company uses both the information on the cost of producing and processing the seed and the price of open-pollinated seed. Since the highest possible price of a particular hybrid variety cannot economically exceed the net marginal gain from using that hybrid, the maximum price of a unit of hybrid seed can be determined as follows:

$$X(P_{hb}) < [P_{op} + (P_{fhb} \times Q_{hb} - P_{fop} \times Q_{op}) - (C_{hb} - C_{op})]$$

where: P_{hb} = the maximum price of hybrid seed,
P_{op} = the price of open-pollinated seed from the public sector,
P_{fhb} = the farmgate price of hybrid grain,
P_{fop} = the farmgate price of open-pollinated grain,
Q_{hb} = the output of grain per unit of hybrid seed,
Q_{op} = the output of grain per unit of open-pollinated seed,
C_{hb} = the cost of cultivation associated with one unit of hybrid seed, (excluding the cost of seed), and
C_{op} = the cost of cultivation associated with one unit of open-pollinated seed, (excluding the cost of seed).

The seed company can charge P_{hb} if it has a monopoly. There are many hybrid seed companies, however, for both corn and sorghum. Product differentiation has been used as a main tool in the competition. Each company has its own hybrid variety, and each has different prices.

The above equation suggests that if the price of the open-pollinated seed (P_{op}) increases, the price of the hybrid (P_{hb}) can also be set higher. On the other hand, if the output per unit of the open-pollinated seed (Q_{op}) increases, the maximum price for the hybrid seed will decrease. To increase the price of the hybrid seed, its yield has to be kept much higher than that of the open-pollinated seed.

The strong public program for open-pollinated corn seed that produced Suwan 1, 2 and 3 has served as the main determinant of the price of corn seed in Thailand. Since the open-pollinated corn seed can be produced by small companies with low operational costs, the prices of the Suwan seeds are kept closer to their marginal costs of production, processing and marketing. The relatively high yield of the Suwan strains puts pressure on the yield of the hybrid. Although the potential yield of hybrid corn seed in Thailand is about 35 percent higher than that of open-pollinated seed, the cost of production (fertilizer, pesticide and labor costs) of hybrid seed is about 20 percent higher. The net gain from using hybrid seed is, therefore, small. Consequently, the price of hybrid is not very high (see Table 4.3).

Most of the hybrid corn companies report losses on their hybrid operation and are forced to sell open-pollinated corn. The profit from the open-pollinated corn is used to offset losses on the hybrid operation. However, building up a marketing infrastructure by selling open-pollinated seed can generate long-run payoffs once these companies develop the right hybrid.

Table 4.3 Selling Price of Improved Seed of Public and Private Seed Companies, 1986 and 1987

Crops	Sale Prices of Seed (baht/kg) DOAE 1986	DOAE 1987	PRIVATE 1986	PRIVATE 1987	KU 1986	KU 1987
Rice	7	7	-	-	-	-
Corn (Suwan 1) (Suwan 2)	12	10	12-16	6-12	12	12
Hybrid Corn	-	-	32-35	18-33	30	30
Sorghum	7	7	(-)	15	12	12
Hybrid Sorghum	-	-	40	37-39	-	-
Soybeans	13	13	12-15	13-18	-	-
Mung Beans	16	16	10	16-22	-	-
Groundnuts	14	14	11-14	11-14	-	-
Yard-long Beans	49	49	18-35	18-35	-	-
Sweet corn	40	40	15-35	15-35	50	50
Tomato	400	-	110-150	-	-	-
Chinese Kale	60	60	40-80	40-80	75	75
Chinese Radish	63	63	30-50	30-50	-	-
Chilli	120	120	100-175	100-175	-	-

Source: Survey.

Production Policy

The production policies of the private companies, especially those of large companies, emphasize the quality of the product in order to maintain their market share. Therefore, large companies have to invest in laboratories for quality control (see Table 4.4), while smaller companies pay less attention to the quality of the product because of their small market share (Table 4.5). Moreover, they can easily change their brand name when farmers lose interest in their old brand name.

Besides maintaining the quality of their products, large companies also have to improve their corn varieties (especially for hybrid corn) to capture a larger market share (Table 4.6). Thus, these companies also send their new varieties to the Kasetsart research station for testing. Ultimately, this development of seed varieties will benefit Thai farmers in general, for they will get good-quality seed.

Table 4.4 Research Budget and Staff of the Field Crop Companies

Company	Research Budget (million baht)	Staff: Permanent PhD	MS	BS	Others	Temporary
Pacific Seed	3	-	3	1	3	12
Ciba-Geigy	7-8	1	2	5	-	60
Charoen Phokhaphan	N/A	1	3	5	-	20
Pioneer	5	2	4	6	-	30
Cargill	-	1	-	5	-	15
Thai Seeds	1	-	-	2	4	10

Source: Sukasem Chitsingh, "Production and Market of Field Crop Seeds by Private Companies." Paper presented at the Seminar on Seed Production Development, Regent Marina Hotel, Pattaya, Chon Buri, January 6-8, 1988, organized by the Seed Division, Department of Agricultural Extension. Ministry of Agriculture and Cooperatives.

Table 4.5 Seed Production by the Private Sector

Major Groups of Seed Companies	Percentage of Area Owned	Total Production Contract Farming
Group A	5 - 30	70 - 100
Group B	5 - 10	90 - 100
Group C	0 - 2	98 - 100

Source: Survey.

Table 4.6 Share of Seed in Total Company Sales and Share of Certified Seed in Seed Sales

Major Groups of Seed Companies	Seed Sales	Percentage of Certified/Extension Seed
Group A	26 - 50	more than 50
Group B	less than 10	10 - 50
Group C	26 - 50	25 - 50

Source: Survey.

Sales Promotion and Competition

Large companies distribute seeds through provincial merchants, but medium-sized and smaller companies are linked to local dealers (Table 4.7). Therefore, sales promotional campaigns are an important activity in the private seed business.

Table 4.7 Distribution Channels of the Private Seed Companies

Distribution Network	Major Groups of Seed Companies		
	A (%)	B (%)	C (%)
Local Dealer	13	65	50
Provincial Merchants	56	-	15
Cooperatives	5	10	5
Bank for Agriculture and Agricultural Cooperatives	18	10	-
Direct Sales to Farmers	8	15	30
Total	100	100	100

Source: Survey.

This study found that seed sales promotional campaigns can be classified into four groups:

1. **Farm demonstration.** Seed companies show the farmer around their demonstration plots, which are designed to highlight the differences between the new and traditional varieties.

2. **Advertising** is commonly practiced by large companies in the form of leaflets, radio and television programs.

3. **Services and gifts** are given to the dealers or directly to farmers either as free gifts and lotteries, or as credits, with the possibility of returning unsold seed.

4. **Discounts** normally are given as special offers by smaller companies because of their lower management costs.

While farm demonstration ranks first in terms of effectiveness, this method is time-consuming and relatively more costly. Most companies use farm demonstrations to penetrate the market. Once the market is aware of the benefit of the hybrid, other sales strategies are used to follow through.

Competition among various seed companies increases the flow of information to the farmer both in terms of cultivation techniques and distinguishing the quality of various seeds. Indeed, corn farmers in areas where there is heavy competition are quite knowledgeable about the quality of the seed used.

VEGETABLE SEED MARKETS

Most vegetable seed companies import some seed, and some of the seed is produced domestically. Keen competition in this market makes it necessary for each company to find the best and cheapest source of supply for its seed.

Price Determination (import tariff)

Import prices and costs of production are the basis for fixing the price of vegetable seeds. However, unlike the corn seed market, where there are many competitors and the quality of seed is quite homogeneous, the vegetable seed market is much smaller, and the seed is not homogeneous. For a given vegetable seed company, the selling prices of other seed companies are deemed to be important in determining the price of its seed. The price of seed varies for different brands. The most established brand is used to determine the price of other brands.

Production Policy

There are two major sources of seed supply for a seed distributor: buying from a domestic producer, or importing. A private company can buy seed from either a contract or non-contract grower. There are also two possible sources of imported seed: the custom seed grower, and the ready-made product.

Less than half of the vegetable seed supply is produced domestically. Most of the open-pollinated seed, such as morning glory seed, is bought from seed growers. The price of this seed is low, and the technology used in production is somewhat simple. Some of this seed is also exported. Imported, open-pollinated vegetable seed accounts for only a small percentage of the market. A small quantity of hybrid seeds are developed and produced domestically by contract farmers, but most hybrid vegetable seed is imported.

The production of hybrid seed requires more sophisticated technical support in plant breeding and cultivation. A domestic seed company used to import these seeds; then it gradually developed experimental plots and was able to make use of custom seed production services in the U.S., Australia and the European countries.

Investment in vegetable seed germ plasm and plant breeding activities is only a recent phenomenon. Until the late 1970s, seed companies were preoccupied with competition, and innovations in marketing strategy were given priority over long-term investment in production technology in research and development. Research activity was stimulated by the establishment of a Dutch company, the East-West Seed Company. Now all large domestic companies are expanding their plant-breeding capability.

Sales Strategies

Product differentiation has been an important characteristic of the vegetable seed market. Vegetable farmers distinguish the seed by its brand. A particular brand will be popular in a particular area. However, farmers will switch to another brand if they or their neighbors experience problems with a given brand.

There are as many as 50 commercial brands of vegetable seed available on the market. Therefore, growers have to select good-quality seed through trial and error.

Brand loyalty makes it difficult for a new company to enter the market. Further, vegetable cultivation is relatively more skill-intensive than cultivation of other crops, and once the vegetable growers get used to a particular growing technique, they are less willing to change. However, they are not resistant to change when they are convinced of the superiority of another brand.

The most effective technique for convincing vegetable growers about the quality of a new product is a demonstration plot in a farmer's field. Direct sales to key dealers and to vegetable growers in the area are also widely practiced to gain access to the market. Advertising to promote sales of new vegetable seed is considered necessary by large vegetable seed companies, who have to provide new seed information to as many growers as possible, to keep their clientele.

It is interesting to note that the strategies of the vegetable seed companies are similar to those of corn seed companies: farm demonstration is used to penetrate the market; pushing the seed to the dealer in the local areas is done to make sure that a company's seed is available on the shelf; and finally, advertising is used to maintain market share.

In conclusion, the seed price is determined not only by the production costs, but also by the demand for and the supply of seed in a given year. For example, in 1986 the grain price was extremely low. Many farmers switched to other crops, while some retained their own seed for the next season. This decline in the demand for seed resulted in an excess supply of seed. Seed-producing companies, therefore, had to cut seed prices in 1987 to reduce their stock; at the same time, some large companies also tried to export the seed to other countries. Thus, the price of corn seed produced by private companies varied that year and was relatively low because of the excess supply. In 1987, however, the price of grain was relatively high because of the low supply, which resulted from the drought. Meanwhile, the supply of seed produced in the same period was also affected by the drought.

Since most sorghum seed sold on the market is hybrid seed imported from Australia and the United States, the seed price is quite stable depending upon the import price.

Chapter 5

Performance of the Seed Industry

The performance of both the public and private sectors can be evaluated based on their objectives and their impact on the development of the seed industry.

PERFORMANCE OF THE PUBLIC SEED PROGRAM

The two main objectives of the public seed program are to promote the use of high-quality seed and to encourage the development of the private seed sector.

Promoting the Use of High-Quality Seed

To achieve this objective the government seed program produces and distributes improved seed to farmers at low prices. The Seed Law sets minimum standards for some of the types of seed sold on the domestic market. Finally, all seed companies are required to register with the Seed and Agricultural Input Control Subdivision of the DOA.

The public sector has played the most important role in promoting the use of improved seed. This is evident in the high adoption rate of open-pollinated crops, such as the high-yielding rice varieties, Suwan corn, and soybeans (see section on the Adoption of Improved Seeds below). There is little private sector involvement in these open-pollinated crops, except for corn. Most rice and upland seeds come from the farmers' saved seed.

A more important question is the extent to which the government should be involved in the seed market; indeed, as the share of the public sector increases, the private sector's share will decrease.

Encouraging Private-Sector Development

To encourage sound development of the private sector, the government has formulated some basic conditions: quality standards, free foreign entry, and public pricing and production. Public research is important to the extent that it induces private research.

- Although there are legal standards for seed and the licensing of seed companies, there is no seed certification system in Thailand. The basic infrastructure needed is a network of seed-testing laboratories throughout the country. Without a reliable quality control system, it is difficult to assure sound development of the seed market.
- Public seed distribution and price directly influence the total supply and market price of seed. Public sector seed distribution determines how much seed is left for the private sector; by adjusting this quantity, the public sector can control the private sector's behavior. Public sector pricing also influences the market price of seed (see Chapter 4). Competition from the public sector can therefore help to maintain efficiency in the market. In actual operation the output of the public seed program is determined by two factors: requests from other public agencies and the production capacity of the Seed Division. Its impact on the private sector has a low priority, if any at all, in public sector production decisions, and given its present approach, it is not possible for the public seed program to enhance private sector development.
- By allowing foreign investors in the seed industry, competition in the private sector has become keener, and this competition will eventually result in better quality seed for a larger number of farmers.

Efficiency in Production

One problem with the public sector is its inefficient operation. The costs to the public sector for producing groundnut and rice seeds are higher than the selling price (Wattanutchariya, 1988). This is because of the rigid regulations that govern the public agencies' routine operations and the incentives structure.

- The amount of paper work that has to be processed by the seed center is much greater than that of any seed company. This bureaucratic internal control system is costly in terms of materials, personnel, and, most importantly, time. This inflexibility renders it difficult for the public sector to adjust to rapidly changing market conditions. Gregg's (1988) recommendations for flexible leaders and equipment does not address these problems.
- More fundamentally, the incentive structure of the seed center is also a problem. The Civil Servant Commission promotion scheme is based on the quantity, rather than the quality, of work. Therefore, producing "more" is in the interests of the personnel in the public sector. To keep the public seed program moving politically, it must expand. Its efficiency is a secondary question. Public seed production needs an alternative incentive scheme that is more suitable to its objectives.

There is also the potential long-term problem of excess capacity that may arise from mismatching supply and demand. While requests from public agencies determine the demand for seed, the public seed production capacity is governed by a long-term plan. Since requests are project-oriented and some are uncertain by nature (e.g., the Emergency Relief Program), there is a strong tendency for demand to decline over the long run. The trend for production is moving in the opposite direction. Therefore, in the long run, there will be a problem of excess capacity.

Gregg (1988) suggests that when that occurs, the seed centers should provide technical support for the private sector. Given such a long-term objective, seed center facilities should be designed differently and should not be as production-oriented as they are currently.

Another related factor stimulating the growth of the public seed program is the push from foreign lending agencies. Almost all seed centers have been built with foreign loans (see Table 3.1). Foreign experts from donor agencies are instrumental in designing and facilitating the expansion of the public seed production system in Thailand. The National Seed Committee should pay closer attention to the long-term needs of the national plan and let funding come as a consequence of the plan. In particular, foreign assistance in the training component should be given more attention, and the acquisition of modern equipment that may not be appropriate for the present national economic condition should be deferred.

The benefits and costs associated with the public seed program have to be carefully weighed against each other to determine the optimum level of public involvement in seed production, over the short and the long terms.

Apart from its role in the production and distribution of seed, the public sector should provide some basic infrastructure and support for the private sector, such as germ plasm and basic plant science research. There is underinvestment in those activities because they do not give quick results and hence are not a popular public expenditure item (Setboonsarng, 1987).

THE PRIVATE SEED INDUSTRY

The private seed industry in Thailand is gradually beginning to take advantage of rapid technological advances in the rest of the world. The private sector's efficiency is discussed below.

Competitiveness in the Industry

In the past, the private seed sector concentrated only on vegetable seed, and the market was dominated by a few large companies. At present, there are a large number of seed companies in both vegetable and field crops. Although each market is still dominated by a few large companies, there is a high degree of competition. With the trend toward specialization in a limited number of crops, a small company can carve out a small market for itself. Recent trends in the research race among private companies in both vegetable and field crops reflect the entry of smaller, more specialized, and newer companies.

Product differentiation is the main marketing strategy of private companies. There are about 100 brands of corn seed and at least 50-60 brands of vegetable seed. The price of the non-brand-name leader is about 10-20 percent below the price of the leading brand.

To remain a brand leader, a company must have relatively strong technical support. Compared to the past, when only a few companies dominated the seed market and choice was very limited, farmers are offered more choice now. This keener competition has slightly lowered the price of seed.

The seed market is now expanding rapidly because of the farmers' growing awareness, which is partly the result of advertising and other sales strategies. Seed companies are reported to spend as much as 10-20 percent of their revenues on sales

promotional campaigns. As the market continues to expand, there will be a higher degree of specialization among seed companies.

Technology transfer

One major characteristic of the private seed sector is its international accessibility, both in terms of seed imports and in terms of foreign investment. This characteristic is responsible for the fast development of the private seed sector in recent years.

The recent research and development race among seed companies, especially concerning vegetable seed, was stimulated by investments made by many foreign companies. Thai companies are forced to keep up with these new companies, particularly in terms of variety of selection. Whether or not these foreign companies transfer technology to their subsidiaries or counterpart companies is not as important as the fact that all companies are now engaging in technological development.

Seed Certification

The fact that the private sector has little interest in establishing its own seed certification system indicates that the value of certification is less than its costs. Competition depends heavily on differentiating one's product, e.g., using a brand name. A certification emblem on the label of a seed can add very little to the farmer's confidence in the product, especially if it is certified by a public organization. Field demonstrations are something that farmers can see and believe.

Nonetheless, a reliable seed certification system could be developed by the private sector; in many countries seed certification is carried out by the seed traders' association or club. With the expansion of the seed market and knowledge of seeds, a privately run seed-testing network would be a useful mechanism to assure the quality of seed in the market.

THE ADOPTION OF IMPROVED SEEDS

Since the improved rice seeds RD-1 and RD-2 were released by the DOA in 1969, the Department of Agricultural Extension (DOAE) has made a great effort to promote these two varieties. Initially, the adoption rate was relatively low because of yield uncertainties and because of eating habits. Farmers were accustomed to the taste of the native varieties.

The expansion of irrigated area in the 1970s facilitated the adoption of modern rice varieties. The adoption rate of modern rice varieties in the irrigated areas of the Northern, Northeastern and Central Regions during the wet season was relatively higher than in the non-irrigated areas (Table 5.1).

The increase in the adoption rate was partly due to the Paddy Seed Exchange Program of the DOAE, which aims to supply improved seed to suit different production environments.

By contrast, the adoption rate for improved varieties of other field crops such as corn and sorghum was higher. Indeed, the private sector played an important role in introducing improved seed to farmers, especially after private seed companies became involved in the 1980s. According to one study by the Department of Agricultural Economics at Kasetsart University, the adoption rate of improved corn

seed increased significantly from 1978 to 1985. At present, all corn-growing areas are planted with improved corn seed, and around 15 percent are hybrid corn varieties (Table 5.2).

Table 5.1 Adoption of Modern Rice Varieties in Selected Areas

Year	North		Northeast		Central	
	Irr.	Non-irr.	Irr.	Non-irr.	Irr.	Non-irr.
	(percentage of area planted with modern variety)					
1970	7.2	-	10.9	-	24.0	0.7
1980	33.6	25.6	72.7	53.6	28.0	0.7
1986	77.1	66.0	94.5	94.6	88.8	16.7

Note: Modern varieties also include improved traditional varieties.

Source: Farm Surveys, various years.

Table 5.2 Adoption of Improved Corn Seed in Major Cultivation

	Percentage of Farmers in Each Variety					
	Native	P.B.X[1]	Thai Comp.[2]	Suwan 1	Suwan 2	Hybrid
1978	68.0	19.7	-	11.9	-	-
1979	64.1	12.5	-	23.4	-	-
1981	7.9	3.7	0.4	75.2	12.8	-
1982	1.2	-	-	81.4	17.4	-
1983	3.7	-	-	75.9	16.7	3.7
1984	-	-	-	29.4	70.6	-
1985	-	-	-	84.2	-	15.8

Notes : [1] P.B.X = Prabhutabat series, which ranges from 1 to 14.
[2] Thai Comp. = Thai Composite.

Source: Wattanutchariya, 1988.

PLANT VARIETY PROTECTION

There is no plant variety protection in Thailand, and, in its current stage of development, the private sector does not think that such protection is feasible. Indeed, it is difficult to imagine such a complicated lawsuit being heard in the busy Thai courts. The cost of enforcing such a system is very high.

Godden (1985) showed that plant variety rights are not an appropriate incentive scheme to induce private agriculture innovation. In practice, trade secrecy is used by private companies to protect their research. Most private companies in Thailand, as well as in other countries, are investing in hybrid seed.

PROBLEMS FACING THE PRIVATE SEED INDUSTRY

The private sector has at least two main concerns regarding the future development of the industry in Thailand:

- **Seed Quality**
  To prevent farmers from receiving substandard seed, the government should strictly enforce means at its disposal for ensuring good quality seed. Substandard seed will tend to slow down the adoption rate of improved seed.
- **Competition from the Public Sector**
  Public sector expansion of improved seed production tends to take business away from the private sector, and the excess capacity of public seed processing facilities threatens private seed enterprises. The Seed Division could consider renting out these facilities to the private sector, a move that would enhance the activity of the private sector.

Chapter 6

Conclusions and Recommendations

CONCLUSIONS

Most of the seed used in Thailand is still the seed retained by farmers ("save seed"). Since the mid-1970s, however, the formal seed market has rapidly expanded. The role of the public sector was crucial at this early stage. Apart from its function in familiarizing the farmer with improved seed varieties, the program also subsidized the poor farmer. The government seed program supplies a small portion of the total seed market and focuses particularly on rice.

The seed industry has expanded significantly and has gone through its first development phase. Thailand has an open policy toward foreign investment and seed imports. At present, there are many seed companies, both Thai and foreign. Seed companies concentrate their activities on maize, sorghum, sunflower, and vegetable seed.

The government performs well in providing seed for open-pollinated crops such as rice, soybeans and groundnuts. However, the public sector is now expanding into the vegetable seed market, which is heavily dominated by the private sector. The question is to what extent the public sector should be involved in these markets. Public-sector participation in the cash market benefits the seed market because a government seed program can serve as a regulatory device; however, this might not be necessary if the public sector can monitor the private sector by other means such as tariff controls.

The public sector's present plan is, however, to increase production. And expanding public-sector production facilities means that there will be more public-sector output for the next few years.

The private sector has switched from competition in the area of marketing to a more quality-based competition. This type of competition is stimulated by the government's open investment policy. It will eventually improve the quality of standard seed on the market. It may not necessarily reduce the price of seed, because the structure of the market is dominated by a small number of companies, especially for the vegetable seed market. This is less true for the corn seed market, where price competition has been very severe.

What has taken place in the seed industry in Thailand in the past five years is difficult to call a revolution, but it certainly marks a big change compared to the 1970s. Modernization is here, and the level of sophistication of farmers, local seed agents and seed companies is increasing rapidly. Indeed, at this pace, Thailand should be able to establish itself in the international seed community within a decade.

RECOMMENDATIONS

Given the expansion of the private sector, public production should probably be reduced and the public sector's role shifted to focus on providing technical support, e.g., quality control, training, research and maintenance of germ plasm.

There are some activities the private sector should take up to provide the industry with a better environment, e.g., by reviving the Seed Club and by setting up a seed-testing network. The main advantage of having a seed-testing network within the private sector is that it will be more flexible and able to accommodate rapid changes in production, processing and marketing technologies. Further, to attract competent personnel to the network, they should receive adequate remuneration. The public sector cannot offer that flexibility.

There are no Plant Breeders' Rights in Thailand. Some private companies, however, have shown interest in such legislation, especially for horticultural crops. The government should study the feasibility of such legislation that is suitable for the existing economic and technical conditions, in addition to studying alternative systems for expanding private research.

Appendix A

The Organization of Research in Plant Breeding

At present, there are a number of private companies involved in plant breeding. However, the involvement of these companies is limited to some cash crops such as corn, sorghum, flowers and vegetables. Most of the research on other crops is still carried out by the public sector. The Department of Agriculture (DOA) of the Ministry of Agriculture and Cooperatives is the main agency responsible for this task. The research at DOA emphasizes the application of new knowledge on plant breeding to Thai agriculture.

Basic research on plant breeding is the responsibility of the universities, such as Kasetsart University and Chiang Mai University in the North, Khon Kaen University in the Northeast, Chulalongkorn University in Bangkok, and the Prince of Songkhla University in the South. Each university conducts basic plant breeding research and specializes in the plants common to its region.

Since 1972, the DOA has reorganized in response to the growing demand for applied research in many crops other than rice. At present, the research work at DOA is done by six research institutes and seven technical units. The six research institutes are:

- Field Crops Research Institute
- Horticultural Research Institute
- Rubber Research Institute
- Rice Research Institute
- Mulberry and Silkworm Research Institute
- Farming System Research Institute

Each institute is responsible for the research, technology development and technology transfer related to its assigned crop. In actual practice, however, there is a great deal of research overlap among these institutes. Most of the farmers in Thailand are small landholders who depend on many crops and many agricultural activities. Large landholders specializing in particular crops are not common.

RICE RESEARCH

The Rice Research Institute (RRI), established in 1935, is one of the country's major research institutes. At present, the RRI is responsible for all aspects of rice research and development and comprises four sections: a) Administration, b)

Monitoring and Evaluation, c) Training, and d) Senior Scientists. There are six regional rice research centers (see Figure A.1) and 18 rice experimental stations throughout the country.

The rice research centers and the satellite experimental stations carry out research work that includes varietal improvement, agronomy, genetics, plant protection, weed science, soil science, seed technology, seed protection, plant physiology, pre- and post-harvest technology as well as farm management and technology transfer.

The research on rice is, of course, the most important activity of the DOA and was its main task until the late 1960s. The expansion of the cultivation of maize and other field crops made it necessary for the public sector to participate in the research and extension of these crops as well. Although there was research on field crops prior to the reorganization of the Ministry of Agriculture and the DOA, it was not until 1972 that research on field crops became recognized as a separate activity. The Field Crop Research Institute was set up in 1972 and concentrated its efforts particularly on maize and sorghum.

FIELD CROP RESEARCH

The Field Crop Research Institute is composed of seven research centers (Figure A.2) and 12 satellite research stations that come under the administrative control of the research centers. These research centers are the focal points of the research undertaken by the institute. Trained researchers are responsible for research on breeding, crop protection, use of fertilizer, soil and water management, cropping systems, seed technology and production, and pre- and post-harvest technology. The research stations are mainly regional testing sites supporting the research undertaken by the research centers. Each research center has been assigned to concentrate on one or two field crops, in addition to a range of multidisciplinary research activities. One of the major tasks of the research station is to supply a sufficient quantity of seed of the recommended crop varieties to the Department of Agricultural Extension (DOAE) to meet the farmers' requests for multiplied seed from the Seed Division. Seed is also supplied to farmers living in the vicinity of the field crop research centers and stations.

In terms of value added in agriculture, fruits and other horticultural crops account for about half of the total value of the agricultural sector. The government has put little research effort in this area. One of the reasons is that horticultural crops are mostly used for domestic consumption. This is changing slightly now because fruits and other horticultural crops like flowers are gaining their share of exports. The government is now giving more attention to research in this area, and the agency responsible for this task is the Horticultural Research Institute.

HORTICULTURAL RESEARCH

The Horticultural Research Institute is responsible for research on horticulture such as fruit trees, flowers and vegetables. There are six horticultural research centers with 10 satellite experimental stations scattered throughout the country. One of the tasks of the center is to produce the foundation seed for the Seed Division of the DOAE. The amount of foundation seed supplied by the DOA has not changed much over the past few years, and the amount of foundation seed for rice has remained at about 532 tons over the past five years.

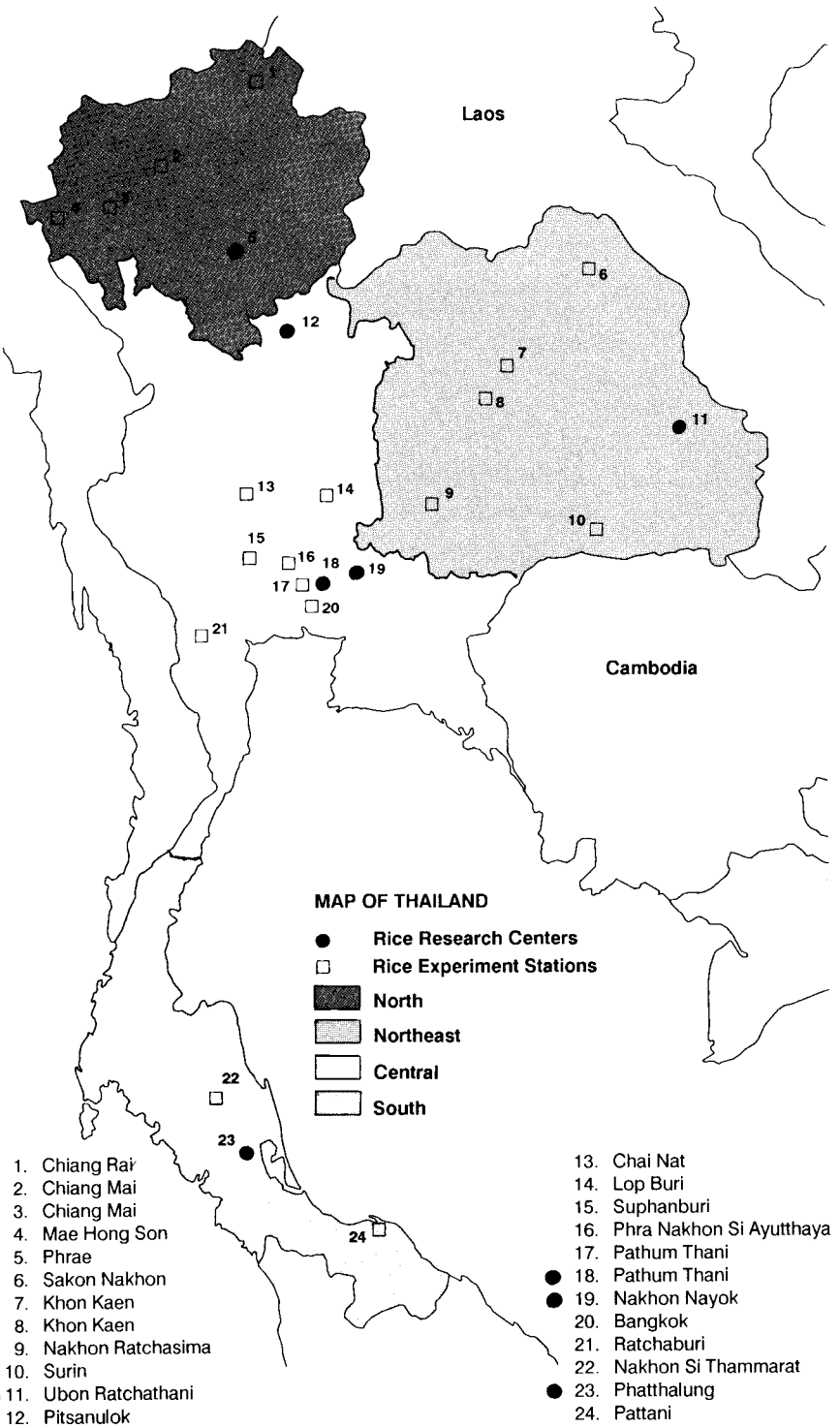


Figure A.1 Rice Research Centers and Rice Experiment Stations, 1988.

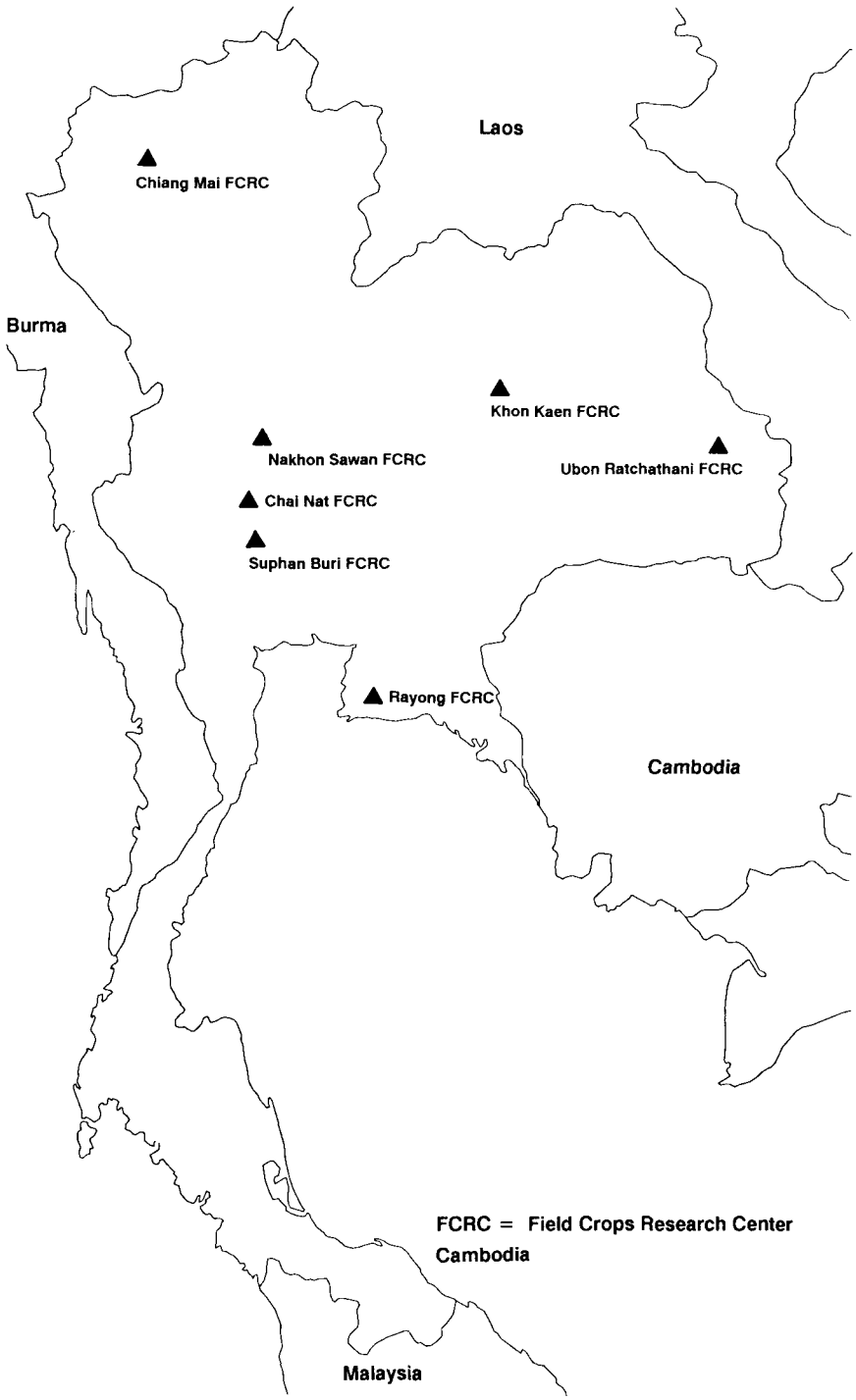


Figure A.2 Field Crop Research Centers

Appendix B

The Development of Improved Rice Seed

Most of the rice seed used by the farmer is selected and retained from the past season. The government has made some effort to improve the quality of the seed. Although public research on improved rice seed has an extensive history, its development still leaves much to be desired when compared to its importance to the economy.

HISTORY OF THE DEVELOPMENT OF BREEDING TECHNIQUES

Among the crops grown in Thailand, rice has the longest history of scientific seed improvement. The first record of research on rice seed varieties was at the Rice Seed Contest held in 1907 at Thanyaburi, a major rice-growing area near Bangkok and site of the first research station in Thailand. The objective of the contest was to select good-quality rice seed varieties to use in experiments at Thailand's first rice research station, established in Thanyaburi. Many varieties of rice were collected from the contest. That event marked the first government effort in plant breeding work.

After a few other contests, a large number of rice varieties were gathered, and breeding activities increased. At the time, the breeding objective was to develop longer grains. This objective was guided mostly by domestic market preferences. In 1933, at the World Grain Exhibition Conference held in Regina, Canada, the Thai rice variety called Pin Kaew carried off first prize for its length. Thai rice also won six other prizes for various distinguished characteristics.

Varieties selected from the rice experimental station were recommended to farmers. As many as eight improved rice varieties were recommended to Thai farmers at this early stage of the rice variety development program. However, the rice yield was relatively low (averaging about 250 kilograms per rai, or 1.56 tons per hectare).

The seed improvement program of the Ministry of Agriculture and Cooperatives became modernized after World War II. From 1950-1954, foreign consultants, such as Dr. H.H. Love, a professor in plant breeding at Cornell University, were assigned to assist the Thai government in developing a plan to improve rice varieties in Thailand under the United States Operation Mission program. Variety and pure-line selection were the only two techniques used to improve rice varieties during that period.

Breeding of new rice varieties in Asia started after the Food and Agriculture Organization of the United Nations (FAO) established the Central Rice Research Institute (CRRI) in India in 1950. Under the Indica-Japonica Hybridization Program, the Institute aimed to develop rice varieties that combined the Japonica characteristic of fertilizer response with the characteristics of the Indica. The Ministry of Agriculture sent four rice varieties to be crossed with the Japonica at the Institute in India and received F2 seed for further research work in Thailand. However, these seeds were not found to be as good as the existing cultivates.

In Thailand, the success of seed improvement by the plant breeding method resulted from the 1966 discovery of the miracle rice, "IR8," by the International Rice Research Institute (IRRI) in the Philippines. This high-yielding variety did not have a good eating quality and was not accepted by Thai farmers. However, when it was crossed with the native variety (Luangthong), two non-photoperiod-sensitive varieties were discovered. They were released in 1969 as government-recommended varieties RD1 and RD3 (RD stands for Rice Department, and the odd number indicates non-glutinous rice, while the even number indicates glutinous rice). These two varieties were particularly recommended for irrigated areas during the dry season.

The breeding program for improved rice varieties has also used hybridization and mutation methods. However, hybrid rice research is still in an early stage of development. A recent report showed that in one season one of the hybrid varieties gave a high yield before failing miserably in the follow-up experiment. Mutation has also had limited success.

THE INTRODUCTION OF RECOMMENDED RICE VARIETIES

Following these technological developments in plant breeding, a number of new high-yielding glutinous and non-glutinous rice varieties, which are disease and insect resistant and suitable for certain cultivated areas, were developed and introduced to farmers throughout the country. To date, the Rice Research Institute has produced 42 recommended rice varieties that can be classified by type of cultivation area and breeding method as shown in Table B.1.

In Table B.1, the types of cultivated areas are classified into lowland, flooded land and upland. Since about 87 percent of the paddy fields in Thailand are grown with lowland rice, 12 percent with floating rice, and 2 percent with upland rice, the development of high-yielding rice varieties is aimed primarily at lowland rice cultivation, especially for the irrigated areas where a dry season crop is made possible only by non-photoperiod-sensitive varieties. In the non-irrigated areas, high-yielding rice varieties were also developed to suit the proper soils and climate conditions in different regions. The RD varieties were usually developed by crossing imported and native varieties, to create a variety with disease- and insect-resistant characteristics. However, the adoption of these new varieties, especially in the wet season, was not satisfactory. Details on the adoption of new varieties will be discussed later.

Table B.1 Recommended Rice Varieties Classified by Type of Cultivated Area and Breeding Methods

Breeding Method	Variety Name	Type of Rice	Photoperiod Sensitive
1. LOWLAND RICE			
A. Hybridization	RD1, 3	NG	NO
	RD2, 4	G	NO
	RD5	NG	YES
	RD7, 9	NG	NO
	RD8	G	YES
	RD11	NG	NO
	RD13	NG	YES
	RD21, 23 , 25, 27	NG	NO
	Neaw Ubon	G	YES
B. Mutation breeding	RD6	G	YES
	RD10	G	NO
	RD15	NG	YES
C. Pure line selection	Kao-Ruang 88	NG	YES
	Kaen Chan	NG	YES
	Khao Duk Mali 105	NG	YES
	Khao Ta Haeng 17	NG	YES
	Khao Pak Mo 148	NG	YES
	Nang Phya 132	NG	YES
	Nang Mon 54	NG	YES
	Nam Sakui	NG	YES
	Pheuk Nam	NG	YES
	Phuang Rai 2	NG	YES
	Hang Yee 71	G	YES
	Neaw Sanpatong	G	YES
	Muai Nong 62M	G	YES
	Luang Pathew 123	NG	YES
	Luang Yai 148	NG	YES
2. FLOATING RICE			
A. Pure line selection	Nang Chalong	G	YES
	Ta Phao Kao 161	NG	YES
	Pin Kao 56	NG	YES
	Leb Mue Nang 111	NG	YES
B. Hybridization:	RD17, 19	NG	YES
3. UPLAND RICE			
A. Pure line selection	Ku Muang Luang	NG	YES
	Siew Mac Chan	G	YES
	Dok Phayom	NG	YES

Note: NG = Non-glutinous; G = Glutinous.

THE IMPORTATION OF RICE SEED TO THAILAND

Recently, the aromatic rice seed, Basmati, was imported from India and Pakistan. It is photoperiod insensitive and can be grown during both the wet and dry seasons. This rice variety is popular in the Middle Eastern countries, and its price is about twice that of other Thai rice varieties. In 1978, the Siam Mati Co., Ltd. imported Basmati 370 from India. It was multiplied and sent to the northern provinces for experimentation.

In 1983, the Asian Chemical Fertilizer Industry Company imported Basmati rice seed from Pakistan for experimentation and planted it in the Central Plain. In 1984 another rice trading company, the Khao Chaiya Porn and Mamrong Rice Mill, imported Basmati 370 to be multiplied and planted in the northern provinces. At present, the area planted with this variety is less than 40,000 rai (6,400 hectares), and no effort has been made to improve this imported variety.

Appendix C

The Development of Improved Corn and Sorghum Seed

CORN

Corn is one of the major cash crops of the Thai economy. The production of corn has increased tremendously during the past two decades, from one million metric tons in 1965 to 4.5 million metric tons in 1985. This increase in corn production was mainly due to the expansion of planted area; the corn yield increased only slightly due to the limited effort of improving corn varieties, especially during the past 10 years. Corn variety development can be divided into four main periods:

Period Prior to World War II

It has been reported that the corn that became the native variety was introduced to Thailand in 1680. It was not until between 1939 and 1946 that two corn varieties (Mexican June and Nicholson's Yellow Dent) were brought from the United States to be planted as animal feed. During that period, however, the cultivation of corn for commercial purposes was still minimal.

Period of Guatemala Variety

In 1950, after the Second World War, the Thai-United States Operation Mission (USOM) Crop Development Project was established. In 1953, H. Ream, project advisor, brought the Tiquisate Golden Yellow corn variety from the Tropical Institute in Guatemala and introduced it to the Thai corn growers in Lop Buri. The planted area of corn increased rapidly after that period. Efforts to improve corn seed varieties started in 1959 with a joint venture between the Department of Agriculture (DOA) of the Ministry of Agriculture, Kasetsart University and the Rockefeller Foundation. Via controlled mass selection, a better quality of the Guatemala variety was achieved. As a result of the effort of this program, two new corn varieties were introduced: PB3 (in 1965) and PB5 (in 1969). (PB stands for Phra Bhudhabaht, the location of the research station of the DOA).

Period of Suwan 1 Variety

Since 1965, downy mildew has been the major problem for corn farmers in the Central Plain, and the Guatemala variety could no longer be used in the affected area. The National Corn and Sorghum Research Center of Kasetsart University was established at Suwan Farm in Amphoe Pak Chong of Nakhon Ratchasima in 1969, and research on downy mildew resistance was carried out at this research station. In 1974 a new variety resistant to downy mildew, Suwan 1, was developed by Dr.Sujin Jinahyon, one of the plant breeders at the university. This discovery gave great momentum to the development of the corn seed industry in Thailand (see the development of Suwan 1 and Suwan 2 in Table C.1).

Besides the discovery of high-yielding and downy-mildew-resistant varieties, research to improve protein content was also added in 1973. Thai Opaque-2 Composite #3 was found in that year. Then experiments were conducted to screen for a variety resistant to downy mildew. Results gave Thai Opaque-1 Composites #4 and #5 in 1976.

Table C.1 Development of Suwan 1 and Suwan 2

Year	Development	
1969-70	Forming of Thai Composite #1	
1970	(S)C1	
Selection of Early Variety		
1971	Thai Composite #1 early	(S)C2 Cross with Phil. DMR 1,5
1972 (S)C1	(S)C3	BC2 (resistant) BC3
1973 (S)C2 Cross with Phil. DMR(S)C1		BC3(S)C1
Selecting the Earliest Variety		
1974 Thai Comp.#1 Early DMR		BC3(S)C1 Suwan 1
1975	(S)C1	(S)C3
1976	(S)C2	(S)C4
1977	(S)C3	(S)C5
1979	(S)C4 Suwan 2	(S)C6
1980	(S)C5	(S)C7
1981	(S)C6	(S)C8
1982	(S)C7	(S)C9

Notes: (S)Ci is the recurrent selection cycle i.
BCi is back crossing i.

Source: Sujin Jinahyon (1984).

Period of Hybrid Corn

It has been recorded that hybrid corn seed cultivation started in 1978. Prior to that period, many different hybrid corn seed varieties were brought in from the United States and the Philippines and tested at Suwan Farm. However, none of the imported hybrid corn varieties performed well in Thailand. Kasetsart University's breeding program started developing hybrid corn by using Thai Composite #1 DMR (S) C4 to establish inbred lines. Finally, in 1980 Suwan 2301, a single-cross hybrid, was commercially released. This new hybrid corn has an average yield 13 percent higher than Suwan 1. In 1982 another hybrid corn strain, Suwan 2602, was found by using the three-way crossing method.

In Thailand, besides government development and promotion of high-yielding corn, a number of companies, both local and international, are actively involved in expanding both Suwan 1 and hybrid corn. It has been reported that the combined production of Suwan 1 seed by all private companies accounted for 10,000 metric tons, while the government supply accounts for only 2,000 metric tons. It is expected that private companies will play a more important role in increasing the production of corn in Thailand, especially with the use of hybrid corn.

VEGETABLE CORN

Vegetable corn in Thailand can be divided into four groups: waxy corn, sweet corn, super-sweet corn and baby corn.

Waxy Corn *(Zea mays var. ceratina kulesh)*

There are no records showing when native waxy corn was introduced to Thailand. In 1968 Philippine Glutinous Syn #20 was brought in from the Philippines and tested in Thailand. The mass selection method was used to select the best-performing Philippine Glutinous Syn #20, and it was distributed to farmers in 1976. This variety was distributed to baby corn growers. At the same time, the Kasetsart University breeding group also managed to develop Super-Sweet Corn DMR, which can be properly used in growing baby corn.

Sweet Corn *(Zea mays var. saccharata sturt)*

Sweet corn was brought into Thailand from Hawaii. This variety, known as Hawaiian Sugar, was evaluated and selected at the National Corn and Sorghum Research Center at Suwan Farm. Several types of high-quality varieties of sweet corn were discovered later on.

Super-Sweet or Extra-Sweet

Super-Sweet was brought into Thailand in 1968 from the University of Illinois. It was tested and developed at several research stations in Thailand. In 1979 Pak Chong Super-Sweet Corn was discovered and distributed to vegetable corn growers.

Baby Corn or Young Ear Corn

Any corn variety can be used as seed for baby corn. However, during the rainy season, farmers will use Suwan 2 because of its resistance to downy mildew. At present, the DOA has successfully developed a baby corn variety known as Rangsit 1, which is also downy mildew resistant.

SORGHUM

It is believed that sorghum was brought into Thailand from the southern part of Tanzania as a tall and late-maturing variety called Msumbiji. This grain was popular food with the merchants who travelled between Africa, the Middle East and India. There are no records of how it made its way into Thailand.

In 1951 a survey by Ream stated that there were more than 100 varieties of sorghum in Thailand. However, SG13 Hegari was the variety that gave the highest yield during experiments conducted at the Research Station in Saraburi. The research on sorghum was also focused on the use of the whole stalk for animal feed.

By 1953, many researchers at the agricultural research stations throughout the Northeast were excited by this new crop and conducted experiments on different varieties of sorghum, such as Yellow Darso, Soonor 2530 and other varieties of Hegari.

In 1956 the research station at Khon Kaen had selected three varieties of sorghum: Hegari 34911, Yellow Darso and Hegari 2565. Two years later, these varieties were tried at different research stations in the North.

Three years after that, in 1959, a livestock consultant from the USOM conducted an experiment on the many varieties of sorghum, domestic and imported. Some of this seed was hybrid, such as RS 650 and Texas 620. The research emphasized the use of sorghum as forage. He found that Yellow Darso grew well at Saraburi, but no other variety performed as well.

Field experiments to test the performance of sorghum in various regions of the country were carried out in 1960 and 1961 using additional imported varieties. Hegari still came out ahead of any other variety.

In 1963 red sorghum attracted the attention of the public for the first time. Because Japan wanted to buy red sorghum, RS 610, which was very popular in the United States, was imported, along with many other red sorghum varieties, for experimentation in Thailand. However, research on white sorghum continued. Yellow Darso, Yellow Milo and Sooner from the United States, and the early- and late-maturing IS from India (Rockefeller Foundation) were tried at different research stations. The late-maturing IS gave a higher yield and became popular among farmers.

The hybrid red sorghum, which has clear endosperm like RS 610 and Texas 610, was brought in from the United States by private companies for crossbreeding with other local varieties. These varieties did not grow well, however, and were very sensitive to disease. The prospects of popularizing red sorghum were dim.

A major step forward in the research and development of sorghum was the establishment of the National Corn and Sorghum Program by the Rockefeller Foundation and Kasetsart University at Suwan Farm in Saraburi in 1966. Additional IS varieties from India were brought in, particularly those with yellow corneous endosperm.

In 1967 an experiment at the National Corn and Sorghum Research Center (NCSRC) resulted in IS 8719 E 173, a brown sorghum, which gave the highest yield; it also had the highest tannin content.

Research on hybrid sorghum first began the following year (1968), using genetic stock from U.S. germ plasm. The wet-pollinated technique popular at that time was employed in this research work. However, at that time all the genetic stock received by the DOA was brown sorghum.

During the same period, plant breeding research at Kasetsart University made more progress with red sorghum, and research using the seed selection technique still continued. The hybrid seed was brought in from India through the Rockefeller Foundation. IS 8719 E 173, a photoperiod-sensitive and late-maturing variety, was again found to give the highest yield. Therefore, in 1973, after a long struggle, the results of experimentation on IS 8719 E 173 in all research stations throughout the country were deemed successful, and its distribution was approved. The news about this brown sorghum spread quickly. Farmers were quick to notice its high tolerance to stress and disease and that its high tannin content reduced damage from birds, unlike white Hegari, which usually suffered from bird damage.

In 1974 the DOA adopted the sorghum random mating populative improvement technique that was used for corn at that time. However, due to limited personnel and difficulties with pollination control, this effort was unsuccessful: the resulting seed was still brown, and its stalk was tall.

Other experiments and trials were being conducted on sorghum from other places, such as White Sudan from Saudi Arabia and P721 from Purdue University in the United States. And a new sorghum, known as Elephant Tail sorghum (used in the tea industry in Japan), was found to be popular among farmers in Nakhon Sawan and Lop Buri.

Research on the quality of the different varieties of sorghum in 1976 found that:

- Hegari (the most popular variety among farmers) is high in carbohydrates and amylose, but it is lower in amylopectin, fat and protein.
- The P721 and Taxioca 63 and Elephant Tail varieties of sorghum are higher in amylosepectin, fat and protein (lysene). However, both P721 and Elephant Tail have severe planting problems. They are susceptible to disease and easily subject to unintended pollination.

In 1977 hybrid seed produced by private seed companies was brought into Thailand. When the yellow corneous endosperm variety from Cargill was tested, it was found to be unsuccessful.

The attempt to cross IS 8719 E 173 with other varieties still continues without much success. In 1978 breeding using radiation was introduced, but the experiment that year was not successful. As a result, in 1980 the breeding objective was changed back to seed selection for non-photoperiod sensitivity and a shorter period of maturity. This research was conducted closely with International Crop Research Institute for the Semi-Arid Tropics (ICRISAT).

In 1981 it was found that the third-generation cross between Ce 151, 262 and A1P1A1 from the Institut de Recherches Agronomiques Tropicales et des Cultures Vivrieres (IRAT), called DA 80, gave a high yield and took only 90 days to mature.

In 1982 DA 80 was released under the name of U-Thong 1 and became highly competitive with privately supplied hybrid. Research on better-yielding varieties still continued with support from the FAO and IRAT.

Appendix D

The Development of Improved Soybean Varieties

The development of soybean breeding in Thailand can be divided into five periods as follows:

1930-1936

It has been reported that soybeans were grown after rice in some provinces in 1930. The varieties used at the time were called small-seed and big-seed varieties, with the small-seed varieties being more popular. In 1934 it was observed that there were two seed varieties – the early variety (90 days to harvesting) and the late variety (120 days to harvesting) – recommended by the district chief officer of Ban Pae, Chiang Mai Province. The two recommended varieties had a great impact on expanding the soybean area, since farmers could now grow soybeans in both the wet and the dry seasons. In 1936 the soybeans were classified into three varieties: Thai, Chinese and Japanese. Sukhothai province was the major growing area at this time.

1951-1959

The second period began in 1951, when 41 U.S. soybean varieties were brought into Thailand for the first time by H. Ream, the USOM upland crop specialist. The purpose was to screen high-quality seed. After conducting comparative variety trials at the agricultural experimental stations in the North (Mae Jo), the Northeast (Tha Phra) and the Central Plains (Bangkok), findings showed the promising varieties to be Palmetto scadian, Semimole and Biloxi. It was also found that the yields of the local varieties collected were better than the five Indonesian varieties that Ream brought into Thailand in 1952. However, the local varieties were highly impure. The impurity could have come from the mixture of seed varieties or from crossing. Therefore, selection experiments to develop a local pure line were conducted. S.B. (soybean) followed by a number was used as the name of the local pure line such as Mae Rim (S.B. 52), Sanpatong (S.B. 54) and Usaha A (S.B. 60). Table D.1 shows some selected seed varieties that were compared during the period of 1951-1959.

Table D.1 Soybean Varieties in 1951-1959

Varieties	Dominant Features
1. Otootan	black seeds
2. Palmetto	resistance to mosaic virus
3. Mackane	–
4. Acadian	resistance to mosaic disease
5. Mussu ura	–
6. No. 27	–
7. Usaha A. (S.B. 60)	susceptibility to disease
8. San Sai	–
9. Mae Jo	–
10. Mae Rim (S.B. 52)	–
11. Pakchong	dwarf stem, good branching

Source: Plant Breeding of Economic Crops in Thailand, Peerasak Srinives and Charoensak Rojanarithphichet, 1986, p.181.

1960-1969

In 1960 Amnuay Wattanawasin brought first-generation F1 soybean seed from Taiwan and Japan to conduct variety trials at the Mae Jo experimental station. After selecting high-quality seed from variety trials up to the fifth generation (F5), only three promising lines were found. Comparisons among the three lines F6, Usaha (S.B. 60) and Pakchong revealed that the three lines gave higher yields. Their names were S.J.1, S.J.2 and S.J.3 to honor the Mae Jo experimental station. In 1965 the DOA approved the release of these three varieties to replace Usaha A. (S.B.60).

In 1969 some Japanese seed varieties were brought into Thailand for variety testing again at the Mae Jo experimental station, and Chiang Mai University collected 125 local and foreign soybean varieties for variety studies.

1970-1976

The Japan International Cooperation Agency (JICA), in cooperation with the DOA, set up a Soybean Development Cooperation Project, which lasted six years (1970 to 1976). One of the project's objectives was to concentrate on soybean breeding.

From 1970 to 1971 the project collected and studied 1,500 soybean seed varieties from various parts of the world to look for standard yield varieties that were better than the existing varieties used by most farmers – S.J.1, S.J.2, S.J.3, Usaha A., Pakchong, Sansai and Phitsanulok. The Mae Jo experimental station was assigned to select the specific dry-season varieties, while the Srisamrong experimental station was assigned to select the specific wet-season varieties. After pedigree selection was carried out from 1971 to 1976, it was found that there were a number of seed varieties that had desirable characteristics, such as high-yield, high-quality seed, resistance to rust, and with high oil content.

It should be pointed out that the cross-pollination of soybean varieties was initiated in 1970 by Japanese and Thai plant breeders at the Mae Jo experimental station. The pedigree selection results showed that S.J.4 and S.J.5 were the two most promising lines. S.J.4 (7019) was the cross between Acadian and Tainung 4 (64104), while S.J.5 (70242) was the cross between Tainung 4 and S.J.2. The dominant features of the two lines are compared with S.J.1 and S.J.2 in Table D.2.

Table D.2 Characteristics of Soybean Varieties

Characteristics	Varieties			
	S.J.1	S.J.2	S.J.4	S.J.5
1. Stem	indeterminate	determinate	determinate	determinate
2. Height (cm)	78.8	58.2	56.2	56.8
3. Days harvesting	94	94	93	92
4. Weight 100 seeds (gm)	12.7	11.5	14.2	14.1
5. Hilum	black	red-brown	light brown	brown
6. Average yield 15 stations, wet season (kg/ha)	1,906.25	1,825	1,900	2,012.5
7. Average yield 9 stations, dry season (kg/ha)	1,543.75	1,531.25	1,600	1,412.5
8. Average yield wet & dry seasons	1,725	1,668.75	1,750	1,712.5
9. Rust resistant	333	343	333	333
10. Antracnose resistant	2	2	3	3
11. Resistance to bacterial pustule	3	3	2.8	3
12. Resistance to downy mildew	3	3	2.5	2.5
13. Resistance to soybean mosaic virus	no	no	no	no
14. Percent of oil	18.44	20.14	17.61	18.74
15. Percent of protein	37.04	39.36	39.04	41.88

Note: Ratings of resistance to disease were evaluated by seed technologists, Department of Agriculture.

Source: Upland Crop Variety, Field Crops Research Institute, 1986.

1977-1986

During the fifth period of the soybean seed improvement activities, the number of agencies concerned with soybean breeding increased considerably. However, at present only two government agencies have been concentrating on crossing and

improving soybean varieties – the Department of Agriculture and Kasetsart University. Other agencies – Khon Kaen University, Songkhla Nakharin University and Chiang Mai University – have been conducting mostly comparative variety studies.

In addition to the four recommended seed varieties mentioned above, the Field Crops Research Institute found the performance of Sukhothai (16.4) or the Phak Bung variety, and OCB, or Nakhonsawan 1 varieties promising. Sukhothai 1 resulted from the screening and comparative testing of hybrid seed varieties from the Asian Vegetable Research and Development Center (AVRDC), while OCB resulted from the screening and comparative testing of varieties from various international agencies, including AVRDC, the International Soybean Program, the International Rice Research Institute and the International Institute of Tropical Agriculture. The dominant features of the two lines are shown in Table D.3 in comparison with S.J.4 and S.J.5.

Table D.3 Dominant Features of Sukhothai 1, OCB, S.J.4 and S.J.5 [1]

Features	Varieties			
	Sukhothai[1] (16-4)	OCB[2]	S.J.4	S.J.5
Stem	Semi-indeterminate	determinate	determinate	determinate
Weight per 100 seeds (gm)	17.2	19.6	15.6	15.2
Average yield wet season (25192526)	293	320	285	236
Resistance to Bacterial pustule	yes	-	susceptible	susceptible
Oil (percent)	-	21.3	17.61	18.74
Protein (percent)	-	39.4	39.04	41.88

Sources: [1] Upland Crop Variety, Field Crops Research Institute, 1986.
[2] Nakhonsawan Upland Crop Research Center.

Another aspect of soybean breeding that should be mentioned is the study done on induced mutation for soybean rust resistance at Kasetsart University (1979-1985). Results indicated some potential for improving soybean seed varieties.

Appendix E

The Development of Improved Groundnut Seed

Groundnuts, a self-pollinated crop like soybeans and mung beans, originated in Brazil and Argentina. So far, India is the major groundnut-producing country. The development of groundnut varieties can be divided into different periods as follows:

1929-1952

In 1929-30 M.C. Sithiporn Kritsdakorn reported the import of groundnuts into Thailand. In 1934 it was reported that the collection of groundnut varieties and comparative variety studies of 27 varieties were started at Tha Phra agricultural experimental station, Khon Kaen, and it was found that the average yields of local varieties were about 79 kg/rai (493.75 kg/ha), while the yields of TVM and TVM3 from India were about 82 kg/rai (512.5 kg/ha) and 79 kg/rai (493.75 kg/ha), respectively.

In 1935 groundnut varieties were classified into three groups – the Thai variety (climbing), the Chinese variety (bunching), and the Spanish variety (early variety). In 1948 Ophas Pholsilp reported that farmers preferred to grow bunching and early groundnut varieties, which took 100 days to harvesting. Thus, farmers could grow two crops of groundnuts per year under rainfed conditions. The selling price of pink groundnuts was reported to be higher than that of red ones. M.C. Sithiporn also pointed out the importance of using improved varieties from government agencies.

1953-1966

Tha Phra agricultural experimental station collected a total of 24 local and foreign groundnut varieties in 1953. In 1957 comparative variety trials on 10 dry-season varieties were conducted at the Mae Jo experimental station. It was found that the Ban Laeng variety gave the highest yield. At the same time, the variety trials on 27 wet-season varieties at the Srisamrong agricultural experimental station showed that the Surin variety gave the highest yield.

In 1959 the Virginia and Valencia varieties were brought into Thailand for variety studies at the Bangkhen experimental station. The days to harvesting of the two varieties were 130 days and 150 days, respectively. In the same year it was found that the Surin variety yielded 459 kg/rai (2,868.75 kg/ha) at the Mae Jo experimental station. It was also found that Tha Phra experimental station had conducted variety studies on 26 local, Indian and Japanese varieties.

From 1961 to 1963 the Roi Et agricultural experimental station collected local and foreign groundnut varieties and classified them into three types – Virginia, Valencia and Spanish. The seed size varied. Some Virginia varieties are Tainan 6 and Tainan 9. The Valencia type comprises Lampang and Sukhothai 38 (SK 38). The Spanish types are Roi Et 1, Nong Khai and Dak.

Meanwhile, primary yield trials of 10-25 varieties under rainfed conditions were also conducted at the Roi Et experimental station in 1962; in the following years it was found that Lampang and SK 38 were the two top-yielding entries. They were finally recommended as improved varieties.

1967-1976

In 1967 pure line selection experiments were conducted at the Roi Et experimental station to solve the impurity problems. Findings showed that Roi Et 1 No. 4 yielded 515 kg/rai (3,218.75 kg/ha) and that the purity of line was as high as 95 percent. The Tha Phra variety ranked second, giving a yield of 512 kg/rai (3,200 kg/ha). From 1968 to 1970 yield trials continued at the Roi Et and Khon Kaen experimental stations and other stations – U-Thong, Mae Jo, Srisamrong and Fang. In 1970 findings showed some interesting varieties such as Tainan 6, Tainan 9, Lonyun 6103 and Lonyun 6102.

In 1973 44 varieties were collected at Kalasin experimental station, and yield trials were conducted. It was noticed that Tainan 9 was the outstanding variety, since its yield performance was better than SK 38, and that Lampang excelled in terms of the number of pods per hill, size of the seed and percentage of shelled groundnuts.

The cooperation program between the Southeast Asia Regional Center for Graduate Study and Research in Agriculture (SEARCA) and the DOA on variety trials started in 1974. The other countries involved in the SEARCA program were Vietnam, Indonesia, the United States and Taiwan. Ten varieties were tested, and it was found that the average yields of Kidang, Cadjah, Tainan 9 and Moket were higher than those of the other varieties.

The results of the yield trials in the North and the Northeast in 1975 revealed that the yield of Tainan 9 was substantially higher. Therefore, a study on suitable days-to-harvesting of Tainan was first initiated that year. Finally, Tainan 9 was approved by the technical committee of the DOA and recommended to farmers in 1976 along with Lampang and SK 38.

1977-1986

During this period, the DOA included the following groundnut breeding activities:

- breeding for resistance to rust and leaf spot (started 1977);
- receiving approximately 250 groundnut varieties from the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) in 1978 and receiving varieties resistant to rust from the United States for testing;
- screening of groundnut lines for tolerance to soil salinity (started 1978);
- hybridization of groundnuts, first started in 1979, to obtain varieties resistant to rust and leaf spot and also giving a high yield;

- research on the improvement of boiling-type groundnuts (started 1980) and also crossing of Lampang, SK 38 and Tainan 9 with collected varieties resistant to rust, leaf spot and *Aspergillus flavus;* and
- receiving hybrids (F17) of 30 lines from ICRISAT and two lines from India. Also starting the program on coordinated yield trials with Khon Kaen University and Kasetsart University (1981-82).

Other institutes conducting research on groundnut breeding up to the present (1986) are Khon Kaen University (KKU), Kasetsart University (KU) and the Prince of Songkla University. The first groundnut research workshop was held in 1981, and the Fourth Thailand National Groundnut Research Meeting was held in 1985. Findings from the research projects conducted at these institutes on groundnut breeding for various purposes include some interesting and promising varieties that should be mentioned.

The standard yield trial conducted on breeding for resistance to rust and leaf spot showed that the top-yielding entry was PI 314817. This line also had lower scores on rust and leaf spot than other entries. (Gadjah x PI 314817)-8-1-18 ranked second, giving an average yield of 123 percent of the check entry Tainan 9. This trial was conducted at the Kalasin and Khon Kaen experimental stations in 1984. In the same year eight high-yielding groundnut lines were screened under soil salinity conditions in a preliminary screening for tolerance to soil salinity. Twenty-three were found to produce good yields and were selected for subsequent testing. Another set of lines that showed good performance in the preliminary tests under soil salinity conditions was evaluated in the late rainy season at Kalasin and Sakon Nakhon. Taiwan No 7 and CPI 13966 were identified as promising entries in this trial, giving yields higher than the check entry, Tainan 9.

Including the boiling-type groundnut lines, the lines were selected from materials received from ICRISAT and other sources, which had passed through the standard yield trial stage. These lines were tested in the dry season in regional yield trials at three locations (Kalasin, Phitsanulok, and Ubon Ratchathani), and three locations (Kalasin, Roi Et and Khon Kaen) in the rainy season. The line ICG 1703 showed a substantial yield superiority to Tainan 9 under both the dry season and the wet season of 1984. Other promising entries are TMV3 and Asiatica.

Lines selected for resistance to *Aspergillus flavus* have advanced to the standard yield trial stage. These lines were progenies from crosses made at Kalasin between adapted lines and a source of *Aspergillus flavus*-resistant (J11). In 1984 these lines were tested at two locations in the dry season (irrigated) and three locations in the rainy season. (Moket x J11)-12-3-26 gave the highest mean yield in the dry season tests, while (Lampang x J11)-1-1-1 ranked first in the rainy season tests. Comparing averages from five locations in two seasons, (Moket x J11)12-3-26 emerged as the top-yielding entry, giving a higher yield than the check entry Tainan 9.

In the rainy season of 1984, primary yield trials of lines from ICRISAT were conducted for groundnut breeding for earliness. They were repeated in the dry season of 1985. The standard yield trial of another group of lines from ICRISAT, which had passed through the preliminary yield trial stage, were tested at two locations (Kalasin and Khon Kaen) in the dry season and six locations in the rainy season (Kalasin, Khon Kaen, Tha Phra, Maha Sarakham, Sakon Nakhon and Rayong). The two highest-yielding entries in this trial were (MGS9 x Chico)-12-16-1 and (MGS9 x Chico)-12-16-5. A few other entries also gave higher yields than the

check-entry, Tainan 9. Another objective of the breeding of groundnuts for earliness is to select varieties suitable for use in growing as a second crop after rice or some other field crop; this requires both early maturity and drought resistance. Standard yield trial results of the lines from IRRI showed that none of the entries gave a higher yield than the check-entry Tainan 9 in the after-rice (irrigated) season; only ULP-PN2 gave the same yield level as Tainan 9. F334-33 showed a slight yield superiority to Tainan 9 in the before-rice season.

Another result of the regional yield trials for lines tested over several years for the early rainy season was that AK-12-24-5 gave the highest yield at Kalasin and Tainan 9 was the top-yielding entry at Roi Et.

Promising groundnut lines identified by the three breeding stations (Department of Agriculture, Khon Kaen University and Kasetsart University) entered into coordinated yield trials under the responsibility of the three institutes mentioned. During the 1984 rainy season there were two series of coordinated yield trials – one for large-seed lines and the other for the regular, medium-sized seed lines. Findings show that the promising entries for the large seed type were (Moket x PI 33739)-11 and (Moket x J11)-12-2-25).

The results of the coordinated regional yield trials in 1983 and 1984 for medium-sized seed types revealed that, averaging 15 tests in four seasons (rainy and dry seasons), Tainung 2 was the top-yielding entry with a yield of 1,418 kg/ha, followed by ICG464SB NCAc17093 (1,406 kg/ha). These two entries gave higher yields than the check-entry Tainan 9 (1,380 kg/ha).

The results of on-farm trials of groundnut varieties in 1984 were classified into two categories: (1) the best entries from regional yield trials were selected for planting in the farmers' fields, and (2) the production trial of varieties comparing recommended practices to farmers' practices. The trials consisted of four entries (Moket, Panjab, Taiwan 2 and Tainan 9), tested in the farmers' fields at Kalasin, Khon Kaen, Sakon Nakhon and Patthalung in the dry season and at Ubon Ratchathani, Mukdahan, Kalasin and Khon Kaen in the rainy season. On average, Moket ranked first, giving a slightly higher yield than the check entry Tainan 9. As for production trials in farmers' fields, two released groundnut varieties (Tainan 9 and Lampang) were compared using recommended practices and the farmers' practices. Findings from some selected locations showed that the two varieties were not much different in yield performance, but recommended practices showed a substantial yield increase over the farmers' practices, particularly in the dry season.

No new varieties have been produced by the agencies mentioned above. Some characteristics of the groundnut varieties (Tainan 9, Lampang and Sukhothai 38) are presented in Table E.1.

Table E.1 Characteristics of Groundnut Varieties

Characteristics	Varieties		
	Tainan	Lampang	Sukhothai 38
1. Stem	Bunch Virginia	Valencia	Valencia
2. Color of stem	Green	Green	Purple
3. Days to flowering	41	37	37
4. Days to harvesting	110-120	100-110	100-110
5. No. of seeds per pod	2	23	23
6. Color of seed	Pink	Pink	Red
7. Weight per 100 seeds (gm.)	42-50	39-48	42-48
8. Weight of seed per weight of shell (percent)	7,280	6,575	6,774
9. Average yield (kg/ha), dry season (1973-75)	2,650	2,281.25	2,450
10. Average yield (kg/ha), wet season (1973-75, 11 plots)	2,512.5	2,237.5	2,168.75
11. Average yield (wet and dry)	2,581.25	2,262.5	2,250
12. Percent of oil	46	48-52	48-54
13. Percent of protein	33	24-25	24-25

Source: Upland Crop Variety, Field Crops Research Institute, 1986.

Appendix F

The Development of Improved Mung Bean Seed

Mung bean is a self-pollinated crop. The methods of variety selection are not different from those of soybeans – pedigree selection, mass selection and pure line selection. So far, all recommended varieties being used in Thailand are the result of comparative variety trials.

The history of the development of mung bean breeding in Thailand may be divided into the following periods:

1937-1957

Mung beans originated in the central area of Asia. The cultivated area for mung beans spread from the west of Pakistan to Japan, the Philippines and Indonesia.

In 1937 it was mentioned that the major mung bean growing area in the wet season was at Sawankhalok, Sukhothai province. The Srisamrong variety, a local variety, was found in 1950 during the study of proper seeding rates of mung bean planting. The study also mentioned the response of the Srisamrong variety to the photoperiod.

In 1957 a study was conducted on growing mung beans after corn at the Ban Mai Sam Rong agricultural experimental station; mung bean seeds were divided into four classes – small seed, golden seed, shiny seed and black gram. It was recorded that the black gram yielded higher than the other varieties. However, the black gram seed was not well known.

1960-1971

The first comparative variety trial was held at Srisamrong experimental station in 1960. From the four varieties tested, it appears that the yield of the shiny seed variety was higher than that of the other three varieties. In 1962 there was a report about the multiplication of the small-seed variety at Ban Mai Sam Rong and a year later, mung bean seed multiplication had expanded to the Northeast to experimental stations in Khon Kaen, Roi Et and Ubon Ratchathani. At the same time, multiplication of black gram was initiated at the Bangkhen experimental station.

In 1969 various seed varieties used in the Philippines were brought into Thailand for line testing. These seed varieties were CES, MG and BPI. At the same time, local seed varieties were also collected for comparative studies at the Mae Jo, Ban Mai Sam Rong, Chai Nat and U-Thong experimental stations.

In 1971 the findings of the Chai Nat agricultural experimental station revealed that the yield of shiny seed (M7A) was promisingly high. The M7A variety was presumed to be in the CES variety group. It was observed that black gram still did not receive much attention from farmers.

1972-1976

The third period of mung bean improvement saw remarkable progress. Comparative variety trials were widely conducted at many agricultural experimental stations. Cooperation between the government and international agencies became actively apparent.

In 1973 the DOA cooperated with SEARCA to conduct comparative variety trials in Thailand, the Philippines, Indonesia, Malaysia, Laos and Kampuchea. In the same year, Chai Nat agricultural experimental station had collected 159 local and foreign mung bean seed varieties (96 seed varieties from the University of Missouri). It was found that most of the seed varieties from abroad had some dominant features, such as dwarf stems and pods breaking when mature.

In 1974 the DOA received 2,082 mung bean seed varieties and 34 hybrid varieties (F3 and F4) from AVRDC for study and screening. The variety trial studies progressed more in 1975, when AVRDC black gram seed varieties were brought back to Thailand, as a result of the Japan Bean Sprout Importers' Association and the Thai Maize and Produce Traders' Association, to conduct research and development on black gram. The results of the studies on the 64 AVRDC seed varieties revealed that 28 seed varieties were black gram and only six seed varieties showed results indicating that further comparative variety trials were warranted. It was mentioned that 34 hybrid varieties were also screened during the wet and dry seasons of the year 1975.

In 1976 nine hybrid varieties that yielded at least as high as M7A were selected for primary yield trials. Finally, on 19 December, 1976, M7A was approved by the technical committee of the DOA and recommended to farmers instead of local varieties. Its common name was U-Thong 1. It should be pointed out that M7A, or U-Thong 1, was not resistant to cercospora leaf spot and powdery mildew, but it is a consistently high-yielding variety. The common name U-Thong was chosen to honor the U-Thong agricultural experimental station, which had done so much work on the pure line selection of this Philippine type.

1977-1986

After U-Thong 1 was approved, the DOA continued its research on the six black gram varieties that showed desirable characteristics according to the standards of the Japan Bean Sprout Importers' Association. Variety yield trials of the six black gram varieties as well as one local variety were conducted at U-Thong agricultural experimental station in both the wet and dry seasons for three successive years. Findings showed three varieties – 68/71, CQ 20147, and PLU 222 – to be promising. However, the seed of the PLU 222 variety was rather small; therefore, only 68/71 and CQ 20147 were sent to the Thai Maize and Produce Traders' Association and crop seed merchants for quality inspection based on market demand. Finally, the association recommended the 68/71 variety for extension to farmers, and the DOA approved the 68/71 variety in 1978. The common name of the 67/71 is U-Thong 2. At the same time, hybridization was initiated at the U-Thong experimental station

to look for new varieties resistant to cerospora leaf spot and powdery mildew. CES 1 D21 varieties and screened AVRDC hybrid varieties were used in crossing. Meanwhile, induced mutation for mung bean and black gram projects, coordinated with the International Atomic Energy Agency (IAEA), were also initiated and findings showed some potential for the further development of new seed varieties.

Some selected AVRDC hybrid and local hybrid varieties were screened in 1979; it was found that the yield of the VC 1178A was nearly the same as that of U-Thong but that its stem was shorter and the time to harvest was seven days less.

Other comparative variety trials on mung beans were conducted at Kasetsart University and the Prince of Songkla University. The Kasetsart University project on mung bean breeding started in 1977, while that at the Prince of Songkla University started in 1980. Meanwhile, the Thailand Outreach Program (TOP), in cooperation with AVRDC, was set up in 1981 to conduct mung bean variety trials. Kamphaengsaen experimental plots of Kasetsart University in Nakhon Pathom province were selected to conduct variety trials focusing on shiny mung bean lines and ordinary lines.

In 1982 11 AVRDC hybrid variety lines including other high-yielding varieties from various countries were sent for comparative variety trials at Kamphaengsaen. Findings showed that the hybrid variety lines – VC 1973A and VC 2778A – were better than U-Thong 1 in terms of yields and other desirable characteristics. With the cooperation from various research agencies, namely, Kasetsart University, the DOA and the AVRDC, standard yield trials and field trials on VC 1973A and VC 2778A comparing them with U-Thong 1, were conducted at various experimental stations in the Central Plains, the North and the Northeast. Findings show that the yields of VC 1973A and VC 2778A were higher than those of U-Thong 1. Moreover, their pods are more easily harvested, as they are above their bunches. It was also found that both varieties were more resistant to cerospora leaf spot and powdery mildew. On the basis of these characteristics mentioned, many farmers tend to prefer VC 1973A and VC 2778A to U-Thong 1. It is expected that the two varieties will be approved by the Committee of the DOA before the end of 1987. The common names of the two varieties – Kamphaengsaen 1 (VC 1973A) and Kamphaengsaen 2 (VC 2778A) – were chosen to honor the Kamphaengsaen campus, Kasetsart University, which had conducted the selections and variety trials on the two varieties. Some selected characteristics of VC 1973A, VC 2778A and U-Thong 1 are shown in Table F.1 and Table F.2.

Table F.1 Characteristics of Kamphaengsaen 1, Kamphaengsaen 2 and U-Thong 1

Characteristics	Varieties		
	Kamphaengsaen 1	Kamphaengsaen 2	U-Thong 1
Height of stem (cm)	3.0	49.9	63.6
First flowering (days)	36.9	36.3	37.3
First matured pod (days)	53.3	53	53.2
Weight (gm/1,000 seeds)	65.6	65.0	64.7
Seeds per pod	10.9	11.1	11.5
Yield	202	189	147
Leaf spot resistance	2.7	2.3	3.2
Powdery mildew resistance	2.9	1.8	4.4
Chemical composition (percent of dry weight)			
Carbohydrate	55.30	52.10	54.70
Protein	27.10	27.30	26.80
Fat	0.89	0.96	0.66

Source: Field Crops Research Institute.

Table F.2 Some Characteristics of U-Thong 2 and a Local Variety

Characteristics	Varieties	
	U-Thong 2	Local variety
1. Height of stem harvested	104	108
2. Days to the first flowering	43	46
3. Days to the first matured pod	71	74
4. Number of pods per plant	52.9	45.7
5. Days to harvesting	89	91
6. Weight per 1,000 seeds (gm)	50.4	48.1
7. Average yield, at the end of wet season	198 (13%)	168
8. Average yield, dry season	180 (10%)	164
9. Average yield, wet and dry seasons	184 (12%)	166

Source: Field Crops Research Institute.

Appendix G

The Development of Improved Tomato Seed

The Thai word for tomato literally means "foreign eggplant." This suggests that the tomato did not originate in Thailand and that it was brought into the country only recently.

However, there is a local variety of tomato that has a diameter of 1-1.5 inches. It has a soft skin and a very sour taste.

The development of tomato seed is being done by both the public and private sectors. For the private sector, a large percentage of sales depend solely on imports. However, the private sector's tomato seed research is accelerating. The earlier development of tomato seed was carried out by the public sector. Public-sector tomato development yielded two popular varieties: Sida (KU) and SVRDC-4.

Sida (KU)

The main breeding objective for tomato seed is to make it resistant to the heat in Thailand. During the period of 1960-1967, many tomato seed varieties were imported from the United States, the leading country in tomato seed research, to be tested and selected in Thailand. The rector of Kasetsart University and the researchers at the Department of Horticulture were the pioneers in this work, but not very much success was reported from those initial selections.

During the period of 1966-1969, Dr. Anothai Chumsai continued this research effort by importing more seeds from the United States, Taiwan and the European countries to select heat-resistant and non-photoperiod-sensitive varieties. He found three U.S. varieties that had an adequate growth at 30-35°C. These are Porter, Porter Pride and Basket Pack. The Porter and Basket Pack were released as recommended varieties during 1968 and 1969.

In 1976 a variety called Sida, which was grown in Samut Sakhon province, south of Bangkok, was found to have a good growth rate and many characteristics in common with Porter. It is suspected that Sida is a cross between Porter and another variety. By the end of 1976, Dr. Anothai started to collect, select and breed Sida using the pure line selection method. Four years later, in 1980, he had developed a new variety called "Sida KU" or "KU Porter," which is still very popular among tomato growers. It is used mostly for domestic consumption and not by the tomato processing industry.

SVRDC-4

A joint effort of the Plant Science Department of Khon Kaen University and the Asian Vegetable Research and Development Center in Taiwan also produced a new variety, "SVRDC-4", which is also heat resistant and popular in the northeastern part of the country.

SVRDC-4 was developed from CL 1131, whose parents are VC 48-1/Tamu Chica III//ah Tm-2a/VC11-1.

Apart from domestic market production, a great deal of hybrid tomato seed is produced for export. The genetic material for these hybrids is imported, but once they are used, they must be destroyed. Therefore, this custom seed production activity has very little externality for the development of the tomato seed industry in Thailand.

Appendix H

The Survey

The seed companies' survey conducted for this study is described in this appendix. There are two methods involved in this study: a questionnaire survey, and in-depth interviews with seed company representatives.

All seed companies are required to register with the Seed and Agricultural Materials Control Subdivision, Department of Agriculture, Ministry of Agriculture and Cooperatives. The seed companies listed in 1984-1985 have been used as the sample for this survey.

A seed company is required to register in one, or more than one, of the three activity categories – collecting, importing and exporting. On the list, 131 companies were registered to collect, 54 companies to import and 34 to export seed. Many companies belong to more than one category.

Through consultations with experts in this area, 59 companies were selected for the survey (see Table H.1). The main criterion was to ensure coverage of large companies to reflect the total seed market.

Table H.1 Distribution of the Sampled Seed Companies

Category	No. of Companies	Sampled	Responded
Collecting	131	-	-
Importing	54	-	-
Exporting	34	-	-
Collecting/importing/exporting	27	15	5
Collecting/importing	14	9	4
Collecting only	90	35	2

Source: Survey.

The questionnaires were prepared by adapting a questionnaire used in the Indian case study. The questionnaire was pre-tested in July 1987. After revision, it was mailed to the 59 selected companies. Some of the questionnaires were delivered to the respondents by hand to ensure response. A telephone follow-up was also

used to stimulate response. However, in spite of these efforts, only 11 companies responded (see table H.2).

Table H.2 Classification of Private Seed Companies by their Activities

	R&D	Import	Multi-plication	Processing	Distribution Domestic	Export
A	x	x	x	x	x	x
B		x	x	x	x	
C			x	x	x	

Source: Survey.

One major reason for this low response rate is that a large number of these seed companies are very small and these small companies tend to be secretive about their operations. Thus, they will not take risks by giving out information about their operations.

While the number of respondents was small, all the big companies did respond, and they represent over 80 percent of the total sales volume. To back up the information from the survey and to compensate for the low response rate, many in-depth interviews with representatives of the major seed companies have been conducted. These interviews were very fruitful and informative. Traders were more willing to provide verbal information, which has no legal bearing on them.

The information from the questionnaire was used in pointing out the general structure of the seed industry. However, the discussion in the text is based heavily on the information from those in-depth interviews.

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ISBN 974-88647-1-5

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The seed industry is an important conduit for transferring new technology to the farmer. However, the majority of the seed used in Thailand consists of seed saved by the farmers themselves. The public sector has been active in agricultural research and in the transfer of new technology to the farmer through its seed distribution program, especially for major crops such as rice, maize, and soybean. The private sector has been active in the hybrid seed market, particularly the vegetable and hybrid maize seed markets. This research monograph assesses the performance of these two sectors and recommends their appropriate roles in Thailand's seed industry.

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