BASIC DESIGN STUDY REPORT ON THE PROJECT FOR ESTABLISHMENT OF CENTER FOR MAIZE QUALITY IMPROVEMENT IN THE KINGDOM OF THAILAND

AUGUST 1986

JAPAN INTERNATIONAL COOPERATION AGENCY

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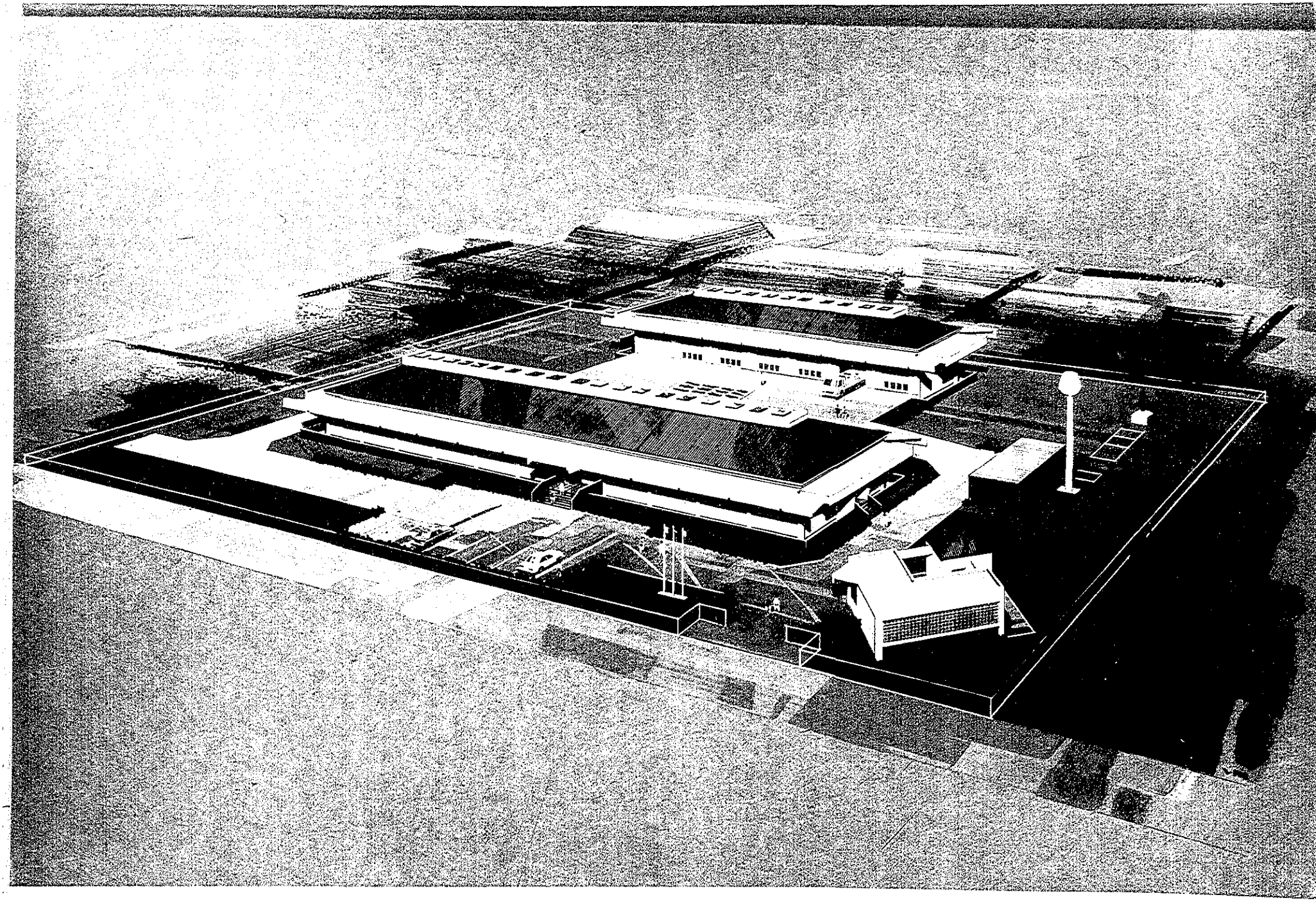

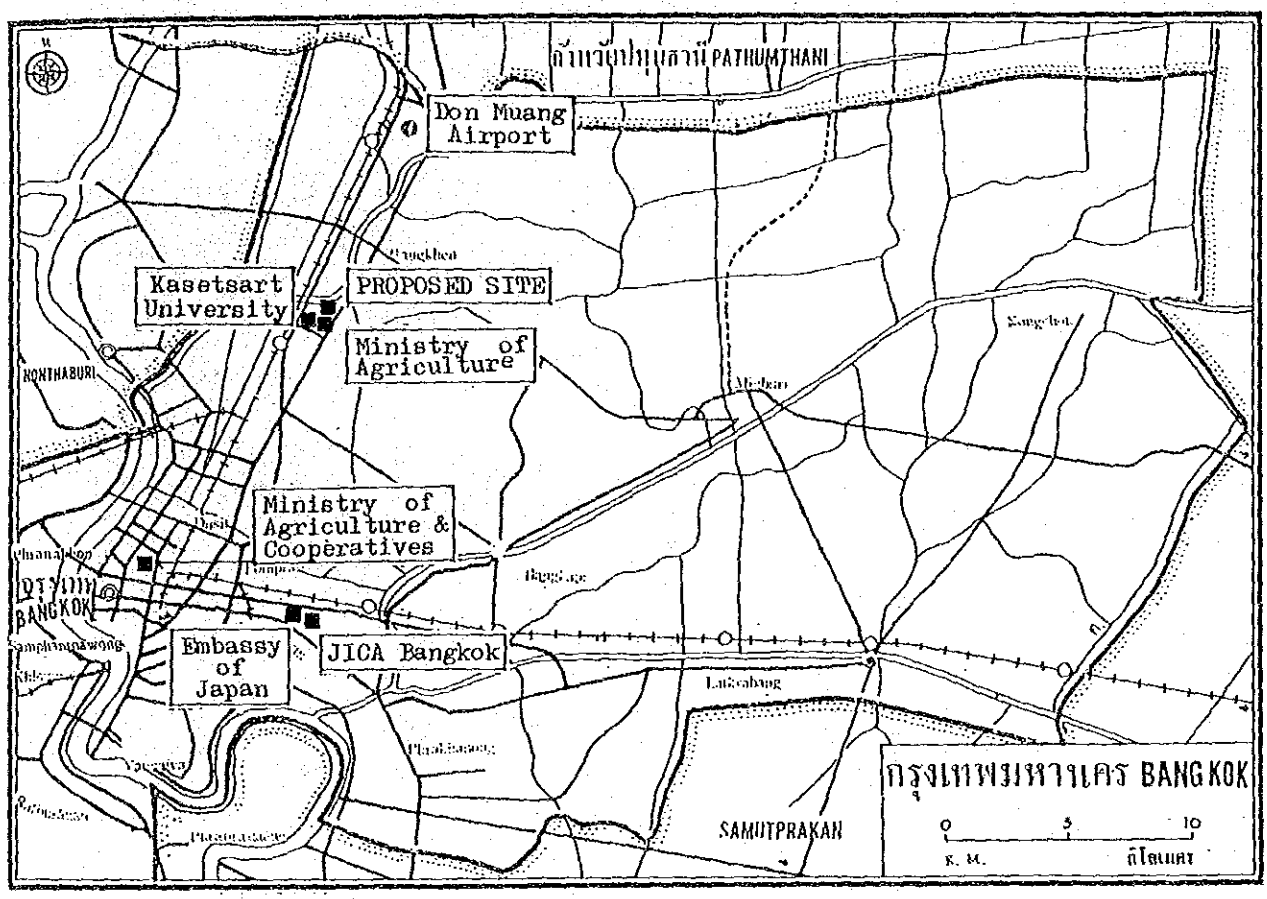

PROPOSED SITE & RELATED GOVERNMENT OFFICES
BANGKOK

PREFACE

In response to the request of the Government of the Kingdom of Thailand, the Government of Japan has decided to conduct a basic design study on the Project for Establishment of Center for Maize Quality Improvement and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Thailand a study team headed by Dr. Masaru MANABE, Director of Applied Microbiology Division, National Food Research Institute, Ministry of Agriculture, Forestry and Fisheries from 9 April to 1 May, 1986.

The team had discussions on the Project with the officials concerned of the Government of Thailand and conducted a field survey in Bangkhen area. After the team returned to Japan, further studies were made, a draft report was prepared and, for the explanation and discussion of it, a mission headed by Mr. Michimasa NUMATA, Senior Planning Officer, Grant Aid Planning and Survey Dept., JICA was sent to Thailand from 7 July to 16 July, 1986. As a result, the present report has been prepared.

I hope that this report will serve for the development of the project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Kingdom of Thailand for their close cooperation extended to the team.

August ,1986

Keisuke Arita

Keisuke Arita

President
Japan International Cooperation Agency

SUMMARY

The Government of the Kingdom of Thailand (hereinafter referred to as "the Government of Thailand") has set "the reinforcement of international competitiveness for its export goods by strengthening and promoting product quality, marketing and technique" as one of the most important policies in the Sixth National Economic and Social Development Plan.

In the field of agriculture, which is regarded as the most important industry in Thailand, the most important policy is considered to be the "expansion of the overseas markets as well as the domestic markets and the sales increase by improving the quality of agricultural products". Thailand produced about 4.5 million tons of maize in the year 1985/86, of which 3.5 million tons were exported while about 1 million tons were domestically consumed as livestock feed. Maize therefore occupies a very important position in the agriculture of Thailand. It has been found, however, that maize produced in Thailand is likely to be contaminated with aflatoxin, and the Government of Thailand is now faced with the most important and urgent task of solving this problem.

Aflatoxin is a toxic substance produced, in conditions of high temperature and high humidity, by Aspergillus flavus. It is said to be a potent carcinogenic natural substance known.

The Government of Thailand has established "The Committee to Solve the Problem of Toxic Substances in Agricultural Products" to meet the problem, combining Government organizations, universities, public corporations and the private sector. However, this problem is not easy to solve since there are not appropriate facilities and equipment suitable for carrying out highly sophisticated scientific analysis and examination.

Under such circumstances, the Government of Thailand asked the Government of Japan for Technical Cooperation in solving the problem of aflatoxin contamination in maize. In response, the Government of Japan

dispatched, through the Japan International Cooperation Agency, a Contact Mission in February, 1985 and consecutively the Preliminary Study Team in September, 1985 in order to discuss the possibility of future technical cooperation. Through the discussion, the Government of Thailand was aware of the imminent necessity to possess sufficient research facilities and equipment, and then, requested the Government of Japan to provide a Grant Aid in January, 1986.

Upon receiving this request, the Government of Japan decided to dispatch the Basic Design Study Team for "The Project for Establishment of Center for Maize Quality Improvement in the Kingdom of Thailand" (hereinafter referred to as "the Project"). The field survey was conducted from April 9 to May 1, 1986 in Thailand.

The results of the study have been compiled in the Draft Final Report. This was submitted to the authorities in Thailand for study and confirmation from July 7 to July 16, 1986. The basic agreements reached are as follows.

The purpose of this Project is to establish a Research Center to carry out basic studies for the maize quality improvement, thereby placing special emphasis on the elimination of aflatoxin contamination.

The Center to be established according to this Project aims at introducing modern analytical technology, thereby investigating the cause of aflatoxin contamination. For this purpose, it also aims at studying and clarifying the relationship amongst cultivation, harvesting, processing and marketing. It further aims at establishing practical methods to eliminate the contamination and at proposing an improvement plan.

The site of this Project is located within extensive compound at Bangkhen district in Bangkok, where Kasetsart University and the other research institutes of the Department of Agriculture stand side by side. The site is now used as an experimental agricultural field. It has an area of about 7,800 m^2, and all elements of the infrastructure are already arranged.

The outline of the Project is as follows:

(1) Facility

. Main building (Administration, Research, Experimentation, etc.)	894 m^2
. Annex building (Storing and processing, Field experiment equipment, etc.)	434 m^2
. Others (Generator Room, Sun Drying Yard, etc.)	172 m^2
Total	1,500 m^2

(2) Equipment

- . Equipment for the analysis of various types of aflatoxin and for the microbiological study on the aflatoxin producing fungi;
- . Experimental equipment to investigate the cause of contamination and to study the storing and processing, etc. with the view of improving product quality;
- . Equipment to analyze data and experimental results;
- . Vehicles and experimenting equipment necessary to conduct a field survey in widespread maize-producing districts.

For the complete execution of this Project, a period of 14 months is considered to be necessary after the Exchange of Notes. For the construction of this Project, the Japanese side is responsible for the construction of buildings, piping, wiring as well as the procurement and installation of the equipment. The Thai side will be responsible for filling in the construction site as well as for the arrangement of water supply, drainage, electric power supply up to the site, etc., for which the cost is estimated at about 4 million Baht (about 25 million yen). The responsible organization for the Government of Thailand to the Project is the Department of Agriculture under the Ministry of Agriculture and Cooperatives. The Plant Pathology and Microbiology Division, the Agricultural Engineering Division and the Field Crops Research Institute will participate in the Project. Upon the Center being established, it will be operated as a research institution under the direct supervision of the Director-General of the Department of

Agriculture. And at the same time, it will be operated as a base of Technical Cooperation of Japan. The research staff to be assigned from the relevant divisions of the Department of Agriculture already have experience in the similar research studies. There will be no problems related to the operation and maintenance of the facilities and equipment. The Department of Agriculture has also inforced its organizational structure for the operation and maintenance of the Center.

The Department of Agriculture takes part in the activities of the above mentioned "The Committee to Solve the Problem of Toxic Substances in Agricultural Products". Thus, the results from experiments and research studies of this Project, including the activities of the Japanese Technical Cooperation programs, are expected to contribute to the development of preventive means and ways against aflatoxin contamination of Thai maize.

This Project is indispensable as the base for Japanese Technical Cooperation scheduled in the near future. At the same time, it will not only contribute to the expansion of export and the acquisition of foreign currency by the improved quality of maize in Thailand, but will also help the national economy through the development of the livestock industry by eliminating toxic feed. Further it will improve the level of public hygiene in the society by preventing the occurrence of cancer.

It is essential to take a comprehensive approach in the elimination of aflatoxin contamination since the causes of which are extremely complicated. In order to achieve the final goal of this Project, where all facilities and equipment completely satisfy their functions, it is important that all divisions and sections, including the Plant Pathology and Microbiology Division, the Agricultural Engineering Division and the Field Crops Research Institute, cooperate fully in research activities. To enable this Center to operate effectively and achieve the expected objectives, it is necessary to educate and technically train the persons responsible in three research fields and to clarify the role of each responsible staff. It is also recommended to strengthen and promote the public relation and extension services in order to extend the benefits of this Project to the level of farmers.

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1. INTRODUCTION

1.INTRODUCTION

1) Project Request

In the Sixth National Economic and Social Development Five Year Plan (1986.10 - 1991.9), the Government of Thailand defines one of the important objectives as: "strengthening international competitiveness with the expansion of productivity and the improvement of quality". In the field of agriculture, it aims at improving productivity by enhancing the quality of agricultural products so that they may meet the international market needs. For these purposes, various policies will be enforced.

Maize production in Thailand has made remarkable progress since 1960, supported by a regional development policy, extension of high-yield varieties and the expansion of overseas markets. Maize not only occupies large export share as a main export commodity but has been achieving steady growth used as a feed ingredient in the poultry breeding industry for domestic consumption. Thus maize plays an important role as one of the main products supporting the Thai economy.

Today, the expansion of arable land for maize has almost reached its limit. On the other hand to achieve increased yield per unit area, it is necessary to develop new varieties of high yield and to develop modern agricultural practices utilizing manure and agricultural chemicals intensively. Under these circumstances, a rapid increase cannot be expected in production. The subject, for the time being, is to improve the quality of the maize to make it an internationally competitive commodity.

In the meantime, aflatoxin contamination of Thai maize has raised serious problems for export. Various measures have been studied, mainly by the Ministry of Agriculture and Cooperatives. Recently, the Thai cabinet approved the establishment of "The Committee to solve the Problem of Toxic Substances in Agricultural Products" which involves not only the Ministry of Agriculture and Cooperatives but various authorities concerned and also the private

sector. Under these circumstances, the Government of Thailand has requested the Government of Japan to extend Technical Cooperation and to Grant Aid for a comprehensive study of the incidence of aflatoxin contamination.

2) Dispatch of the Preliminary Study Team

In response to the request of the Government of Thailand, the Government of Japan decided to dispatch a Contact Mission for the project of "Development of the Pre and Post Harvest Techniques to Prevent and Protect the Incidence of Aflatoxin in order to improve Corn Quality" in February, 1985.

Then, based on the discussions between both Governments, the Government of Japan dispatched a Preliminary Study Team to Thailand through the Japan International Cooperation Agency in September, 1985, for "The Project of Quality Improvement in Corn in the Kingdom of Thailand".

After discussions with the authorities concerned of the Government of Thailand, the preliminary study team made their summary report and presented it to the Director-General of the Department of Agriculture.

This report says that the establishment of a research facility is indispensable for analysis of contamination factors, improvement of testing techniques, establishment of countermeasure and extension of aflatoxin prevention methods.

3) Dispatch of the Basic Design Study Team

Based on the study results obtained by the Preliminary Study Team, the Government of Japan dispatched the Basic Design Study Team on April 9, 1986. This team, headed by Suguru MANABE, Director of National Food Research Institute of the Ministry of Agriculture, Forestry and Fisheries, stayed in Thailand until May 1 of the same year.

The study conducted by this team covered the background of this Project, various activities already developed in Thailand with respect to the prevention of aflatoxin contamination, clarification of the validity of this Project and the study of a proper basic design of the facility and the equipment to be constructed at Bangkhen. This study team had detailed discussions with the officials of the Department of Agriculture of the Ministry of Agriculture and Cooperatives. The team also had discussions with the Deputy-Director General of the Department of Agriculture, the responsible officer for this Project in Thailand, and with officials concerned with this Project's executing and management systems for the proposed Center. Discussions also covered the scope of work to be undertaken by the Government of Thailand.

As a result of these studies, the Basic Design Study Team concluded that there is an urgent need for a central body, to make intensive efforts to raise its technological level, especially in research and development and that the Department of Agriculture is the appropriate one to function as the executing organization for this Project.

The discussions concerning this Project made between the study team and the Department of Agriculture as well as the basic agreements reached through these discussions were compiled as the Minutes of Discussions dated April 18, 1986. (See the appendix (1)-(a).)

Based on these results, this Project has been studied in detail in terms of optimum contents, size, construction schedule, etc. After consultation with experts to be dispatched for Technical Cooperation, the results of the study have been compiled in the Draft Final Report. This was submitted to the authorities in Thailand, and a confirmation study was conducted from July 7 to July 16, 1986. As the result, a basic agreement has been reached, and the Minutes of Discussions have been exchanged with the signatures of the officials concerned. (See the appendix (2)-(a).)

This Basic Design Report finally compiles the conclusion of the study on the viability of this Project, and the contents of the optimum basic design for implementation of this Project, based on the field survey results and analysis of pertinent data and information.

2. BACKGROUND OF THE PLAN

2.BACKGROUND OF THE PLAN

2-1 National Development Plan

The National Development Plan in Thailand operates based on the Five Year National Economy and Society Development Plan issued by the National Economy and Society Development Bureau. The plan was launched in 1961 as the First Five Year National Economy and Society Development Plan and, at present, the Fifth Plan (1982 - 1986) is underway. In November, 1986, the Sixth Plan (1987 - 1991) will begin.

The Fifth Five Year National Economy and Society Development Plan (1982 - 1986) reveals the following 6 political targets.

a) Recovery of economical and financial position

- Suppression of excessive financial spending to foreign countries -

b) Modification and restructure of national economy

- Improvement of productivity, move to exporting industries, decentralization of industries, reduction in the proportion of imported energy -

c) Improvement of social service systems

- Suppression of the ratio of population growth, educational, sanitary, legal and social securities, improvement and impartialization of services -

d) Settlement of poverty in less advanced areas

e) Harmonization of economical developments and national defense

f) Improvement of development administration

Relative to the ever-changing international economy, the performance of the national economy in Thailand is rather stable. The annual growth

rate of 5.3% is close to twice as high as the average world figure, although the target of 6.6% was not achieved. In addition, the long-standing negative current balance will be reduced to BHT 56 billion, equal to the deficit in the final year of the Fourth Plan (1981).

The Fifth Plan originally aimed at an annual trade deficit to GNP less than 4.1%. In 1983 when export was depressed, the ratio of trade deficit to GNP amounted to 7.2%, i.e., BHT 66 billion. As such, the Thai trade deficit will not be easily solved due to the conditions of the world economy.

From the conditions and constraints which have been analyzed above, together with the consideration of opportunities and possibilities of future development of the country, the Sixth Plan will necessarily have a direction for development that includes 2 overall targets, 4 main strategies, and 10 working programs.

2 Targets

(1) Set the economic growth target to be at an average of more than 5 percent per annum. This is done by emphasizing the pattern of growth that will encourage effective employment generation, distribution of income, and the maintenance of an economic balance that will create opportunities for stable and continuous economic development.

(2) Develop human quality to enable progress in social development and to create peace and fairness in society. Social development must be consistent with, and assist in, the overall development process of the country. Together with the preservation of national identity and desirable attitudes, social development must help improve the quality of life in the rural and urban areas according to the criteria for basic necessities.

4 Strategies

(1) Continue to proceed in the development and adjustment of economic and social framework of important policies carried over from the

Fifth Plan. At the same time, seek for new opportunities that will lead to economic progress and a wider distribution of benefits to the general population. However, prime consideration must always be given to economic limitations and the maintenance of the country's fiscal and monetary stability.

(2) Increase efficiency, improve quality in production, marketing, and technology, and reduce production costs to be able to better compete with other countries.

(3) Promote the development of human quality to possess the knowledge and capabilities that are beneficial in the development of life, career, and society, by mainly emphasizing the principle of self-reliance. Social development must be consistent with career development and economic development especially in creating discipline and respect for law and order; and in developing of virtue, ethics, and unity among the population. This, in a way, will reduce the responsibilities of the government and encourage frugality and savings.

(4) Adjust the role and the management organizations of the government sector including regulations, orders, and laws; to be suitable to development directions. Considerations must be given to the limitations in the capabilities and fiscal status of the government. There will be an appropriate sharing of the development burden between the government sector, state enterprises, and the private sector under the integration principle.

10 Working Programs

(1) Economic and Financial Stabilization Program.

(2) Natural Resources Development and Environmental Management Program.

(3) Rural Development Program.

(4) Urban and Specific Zones Development Program.

(5) Program to Develop Society, Human Quality, Human Resources, and Labor.

(6) Program to Develop Production, Marketing, Technological, and Employment Generation Systems.

(7) Basic Services Development Program.

(8) Science and Technology Development Program.

(9) State Enterprises Development Program.

(10) Program to Improve Management and Review the Government's Role in the Development Process.

The foregoing items constitute the master plan for the Sixth Five Year National Economy and Society Development Plan. Among others, agricultural products constitute the financial basis for Thailand in the international industrial society, with a view to increasing the international competitive power by enhancing the productivities, qualities and marketing of export products. The policies of the plan are characterized by the following 3 items:

a) Review of the projects with more emphasis on economical harmonization.

b) The productivities and qualities of export products are to be enhanced together with reinforced marketing, thereby competitive power in international trade will be increased.

c) The government will share suitable functions and roles with the private sectors throughout these development works.

2-2 Outline of Agricultural and Fishery industries in Thailand

2-2-1 Economical Features of Agricultural and Fishery Industries

The agricultural and fishery industries in Thailand are much larger than other Thai industries. Agricultural and fishery products occupy an important sector of the commercial and processing activities in Thailand, acting as a trunk industry in the Thai economy.

(1) Agricultural and fishery products make up 22.0% of the gross national production (1984), occupying the first place far ahead of manufacturing industries and trading business firms.

(2) Agricultural and fishery products make up about 50% of the annual gross exports. Furthermore, the share becomes larger than 60% when processed agricultural and fishery products such as sugar, molasses and canned pineapples are included.

(3) 67% of total employees work in the agricultural and fishery industries; much larger than the 19% for commercial employees and 8% for the employees in manufacturing industries.

Major agricultural products exported from Thailand include rice, cassava, maize, sugar and rubber, etc. for acquiring foreign currencies. These products are international crops which are traded in rigorous free competition. However, the agricultural industry production systems are not always modernized. Instead, the products are supported by the lower wages of the agricultural labor force along with the highly productive environments of tropical high temperature and humidity.

2-2-2 Basic Indices of Agriculture

(1) Agricultural Land

The ratio of Thai agricultural land is as high as 36.6% to the whole land area, in which paddy fields occupy 22.7% and other up-land crop fields for cassava, maize, sugar, etc. share 7.8%.

A	Whole national land	51,400 thousand ha
B	Agricultural land	18,811 thousand ha
	1. Paddy fields	11,657 thousand ha
	2. Other fields	4,041 thousand ha
	3. Orchard	1,767 thousand ha
	4. Grasslands	83 thousand ha
	5. Others	1,263 thousand ha

Agricultural land has been greatly increased from 10,560 thousand ha in 1961 to 18,810 thousand ha in 1980. This increase was caused mainly by up-land crops, particularly the significant expansion of the fields for maize and cassava.

(2) Number of Farmers and Possession of Lands

The number of Thai farmers is significantly increasing because of the recent increase in the population. Looking at the trends in the past 20 years for example, 3,450 thousand farmers were present in 1961 but, in 1980, the number of farmers increased to 4,410 thousand households, an increase of 28%, close to about 1 million households.

In view of land possession, the agricultural census issued in 1978 lists 3,420 thousand independent farmers, namely 85% of the total 4,020 thousand farmers. The balance of 15% includes tenant farmers (230 thousand households), independent/tenant farmers (280 thousand households) and no-land farmers (48 thousand households). The number of no-land farmers is only 1.2% of total farmers.

In 1980, the average agricultural land per farmer was 4.27 ha which is decreasing recently.

(3) Agricultural Income per Household

The agricultural income per farmer in Thailand shows significant differences depending on districts as shown in the following table. More explicitly, these differences in agricultural income might be caused by the different income of crops. For example, in the north-eastern part where many farmers are sustaining their life with

the up-land crops like cassava, maize and kenaf, average income is BHT 7,631, as low as about a half of the national average. On the other hand, in the center part where rice is mainly grown, the average income is BHT 30,763, 7 - 8 times as high as that in the north-eastern part.

Unit: BHT

	1975	1976	1978
National	9,653	12,224	14,901
North-eastern part	4,829	5,424	7,631
Northern part	9,363	13,256	15,654
Central part	23,069	28,642	30,763
Southern part	7,935	7,766	13,411

(4) Classification of Agricultural Area

The Thai administrative classification includes 73 Changwats (a Changwat consists of 10 - 15 Amphoes) including Bangkok, Amphoes (comprising 5 - 6 towns and villages), Tambons (comprising 10 - 20 hamlets) and Mubans (comprising 100 - 200 households).

The Thai Ministry of Interior classifies, in view of convenience for administration, the foregoing 73 Changwats into 4 districts, "North Thailand", "North-Eastern Thailand", "Central Thailand" and "South Thailand".

On the other hand, the Ministry of Agriculture and Cooperative divides the country into 19 zones in terms of soil, rainfall, temperature, traffic networks, etc. for agricultural guidance and promotion.

(5) Planted Area and Production of Major Crops

At present, rice retains the largest planted area; in 1984/'85, there was about 62.33 million Rai (about 9.8 million ha) as a total of the first and second crop. Others include 10 million Rai (about 1.6 million ha) for rubber, 11.36 Rai (about 1.8 million ha) for

maize, 8.78 million Rai (about 1.4 million ha) for cassava and 3.42 Rai (about 500 thousand ha) for sugar cane.

According to recent trends, internationaly traded crops such as cassava, maize and sugar cane are greatly increasing. The production of rubber is also steadily increasing. In particular, cassava and maize are expanding their boundary areas by developing forestry areas as roads have been constructed and expanded. Rice is also linearly increasing because of the popularization of improved varieties, renovation of cultivating techniques and the expansion of double cropping areas.

Planted Area and Production of Major Crops

	Planted Area (1,000 Rai)				
Year / Crop	1980/81	1981/82	1982/83	1983/84	1984/85
Rice	60,110	59,970	60,134	62,596	62,329
	(100)	(100)	(100)	(104)	(104)
Maize	8,960	9,796	10,494	10,552	11,355
	(100)	(109)	(117)	(118)	(127)
Cassava	7,250	7,940	7,726	8,552	8,780
	(100)	(110)	(107)	(118)	(121)
Sugar Cane	2,927	3,857	3,645	3,606	3,424
	(100)	(132)	(125)	(123)	(117)
Rubber	9,615	9,867	10,001	10,143	10,254
	(100)	(103)	(104)	(105)	(107)

	Production (1,000 ton)				
Year / Crop	1980/81	1981/82	1982/83	1983/84	1984/85
Rice	17,368	17,774	16,879	19,549	19,905
	(100)	(102)	(97)	(113)	(115)
Maize	2,998	3,449	3,002	3,552	4,226
	(100)	(115)	(100)	(118)	(141)
Cassava	16,540	17,744	17,788	18,989	19,985
	(100)	(107)	(108)	(115)	(121)
Sugar Cane	19,854	30,200	24,407	23,869	25,055
	(100)	(152)	(123)	(120)	(126)
Rubber	465	508	576	594	617
	(100)	(109)	(124)	(128)	(133)

Note : ( ) Growth Index based on 1980/81
Source : Agricultural Statistics of Thailand

2-3 Outline of Maize produced in Thailand

2-3-1 Trends of Production

The production of maize in Thailand has dramatically expanded, particularly after the 1960s. In 1953/'54, production quantity was only 50 thousand tons. However, production has significantly increased; 850 thousand tons in 1963/'64, 2.3 million tons in 1973/'74 and 3.55 million tons in 1983/'84. More recently, 4.22 million tons was recorded in 1984/'85.

The major production area of maize in Thailand spreads on a gentle slope extended from the upper reaches of Chao Phraya Delta to the northeastern part. The top 6 production areas of maize in 1984/'85 are Phetchabun (795,470 tons), Lop Buri (533,565 tons), Nakhon Ratchasima (393,234 tons), Nakhon Sawan (404,244 tons), Loei (379,358 tons) and Saraburi (255, 222 tons). Total production in these 6 areas amounts to 2.73 million tons, about 60% of the total national production in the same year.

2-3-2 Factors for Production Expansion

Reasons why maize production in Thailand has grown rapidly as described before include the following effective factors.

(1) Enactment of Land Law

According to the land law enacted in 1959, land ownership is granted if a person exploits national land and cultivates the land for 3 years within a limit of 50 Rai. Such a policy stimulated the farmers to develop new lands, resulting in the expansion of planted maize areas.

(2) U.S. Assistance for the Development

USOM (United States Operation Mission to Thailand), organized in 1950, has assisted in the construction of a marketing infrastructure for crops, such as the construction of trunk roads aiming at

stabilizing Thailand politically and economically. As a result, transportation facilities between the main maize production areas and Bangkok have been improved while greatly urging maize production.

(3) Promotion by the Government

The Thai government took national policies to encourage the production of maize in the Third National Economy and Society Development Plan (1972 - '76) by adding maize to the 6 crops recommended for increased production.

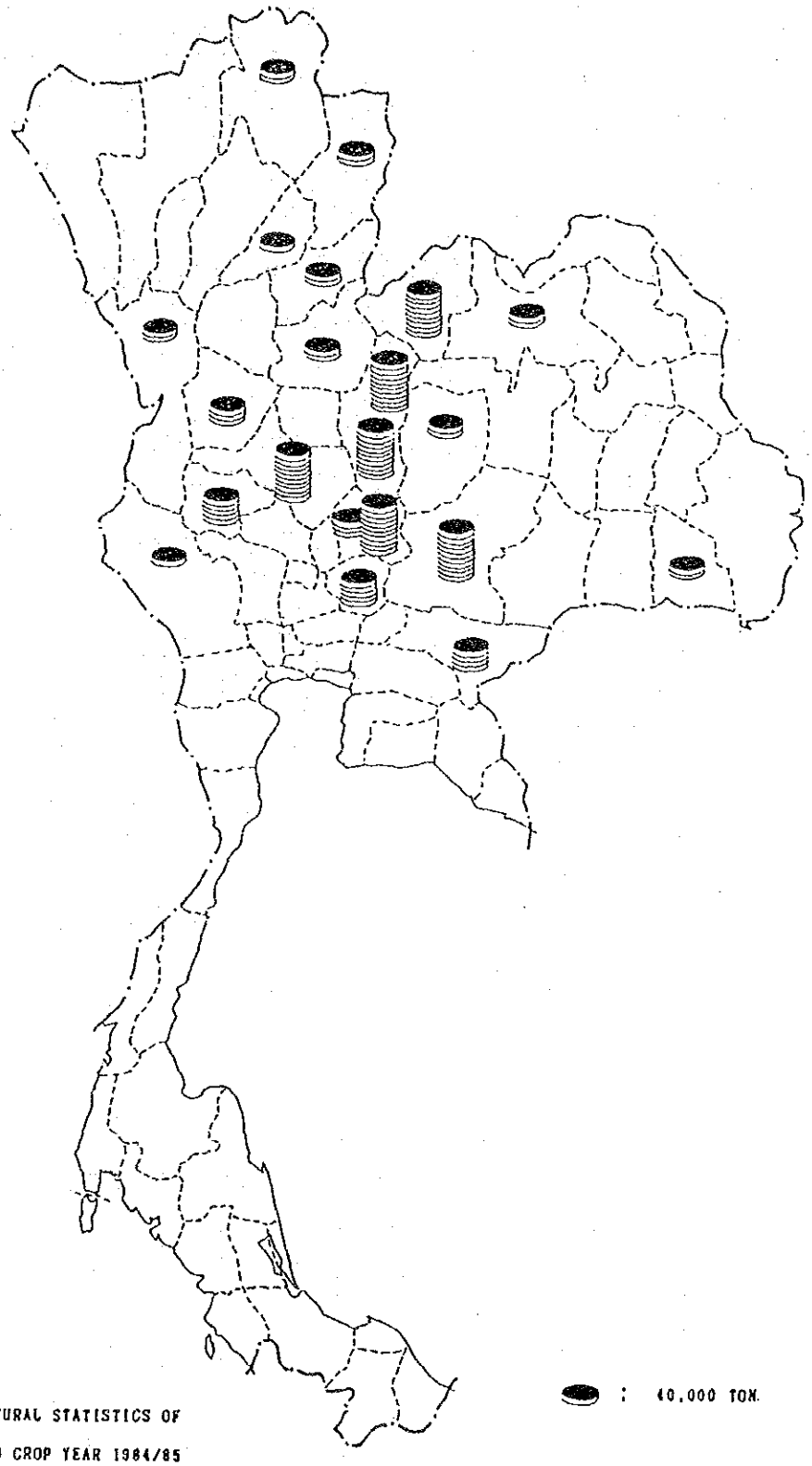
(4) Extension of New Varieties

Improved varieties such as Suwan Nos. 1 and 2 have been successfully developed by repeated cross-breed experiments which are characterized by strong resistivity to downy mildew diseases and drought while assuring certain yield. The mean yield in Thailand is 370 Kg/Rai while Suwan Nos. 1 and 2 bringing about a mean yield of about 500 Kg/Rai. At present, more than 50% of all maize farmers are cultivating these varieties according to governmental recommendation.

(5) Strong Overseas Demand

Overseas demand for maize has been greatly expanding, particularly demand for poultry, and stock raising industries are steadily growing. For example, the estimated demand for maize in Asia, including Japan, increased to about 30 million tons. Such a strong demand from overseas countries has encouraged the farmers to cultivate maize.

Major Maize Production Changwats



: 40,000 TON.

Source
: AGRICULTURAL STATISTICS OF
THAILAND CROP YEAR 1984/85

MAIZE : PLANTED AREA, PRODUCTION AND AVERAGE YIELD (By Region)

Planted Area : 1,000 rai
Production : 1,000 tons
Average Yield : kg/rai

Year	Northern			North-Eastern			Central Plain			Southern			Out Surveyed Area			Total		
	Planted Area	Production	Average Yield	Planted Area	Production	Average Yield	Planted Area	Production	Average Yield	Planted Area	Production	Average Yield	Planted Area	Production	Average Yield	Planted Area	Production	Average Yield
1960/61	85	24.8	292	506	154.2	305	1,075	332.3	309	119	32.7	275	-	-	-	1,785	543.9	305
1961/62	15	4.2	280	329	75.6	230	1,530	507.5	332	42	11.0	262	-	-	-	1,916	598.3	312
1962/63	23	6.2	270	277	68.0	245	1,724	584.8	339	26	6.4	246	-	-	-	2,050	665.4	325
1963/64	29	7.3	252	247	64.4	261	2,307	778.7	338	29	7.3	252	-	-	-	2,612	857.7	328
1964/65	48	12.0	250	253	63.4	251	3,113	851.8	274	36	7.9	219	-	-	-	3,449	935.1	271
1965/66	84	20.7	246	296	69.2	234	3,160	916.6	290	66	14.7	223	-	-	-	3,605	1,021.3	283
1966/67	191	53.4	280	436	110.8	254	3,377	939.7	278	79	18.5	234	-	-	-	4,083	1,122.4	275
1967/68	204	49.2	241	524	122.7	234	3,823	1,020.2	267	99	20.2	204	-	-	-	4,650	1,212.3	261
1968/69	2,157	610.3	283	647	129.5	200	1,838	554.8	302	120	36.5	303	-	-	-	4,762	1,331.1	280
1969/70	1,946	746.3	383	501	165.0	329	1,801	705.5	392	-	-	-	255	96.7	380	4,503	1,713.5	381
1970/71	2,369	821.7	347	689	280.0	406	2,064	813.2	394	-	-	-	58	23.3	400	5,180	1,938.2	374
1971/72	3,112	1,098.3	353	1,006	401.5	399	2,029	734.2	362	-	-	-	220	66.0	300	6,367	2,300.0	361
1972/73	2,814	655.6	233	1,110	215.6	194	2,057	368.8	179	-	-	-	250	75.0	300	6,231	1,315.0	211
1973/74	3,503	1,154.0	329	1,536	456.0	297	1,903	648.0	341	-	-	-	230	81.0	352	7,172	2,339.0	326
1974/75	3,624	1,207.0	333	1,874	553.0	295	2,011	671.0	334	-	-	-	240	69.0	287	7,749	2,500.0	323
1975/76	4,032	1,440.8	357	2,143	704.1	329	2,024	718.3	355	-	-	-	-	-	-	8,199	2,863.2	349
1976/77	3,502	1,212.4	346	2,587	744.2	288	1,857	697.7	376	83	20.9	252	-	-	-	8,029	2,675.2	333
1977/78	3,757	916.6	244	1,860	394.4	212	1,581	283.8	179	86	28.7	334	250	53.0	212	7,534	1,676.5	223
1978/79	4,795	1,632.9	341	2,048	556.9	272	1,795	596.2	332	23	4.6	196	-	-	-	8,661	2,790.6	322
1979/80	5,007	1,541.3	308	2,437	673.5	276	2,055	639.4	311	30	9.0	300	-	-	-	9,529	2,863.2	300
1980/81	4,658	1,647.9	354	2,267	730.4	322	2,016	614.5	305	19	5.0	260	-	-	-	8,960	2,997.8	335
1981/82	4,519	1,615.0	357	3,044	970.8	319	2,233	862.7	386	-	-	-	-	-	-	9,796	3,448.5	352
1982/83	4,768	1,393	357	3,132	768	335	2,594	841	428	-	-	-	-	-	-	10,494	3,002	368
1983/84	5,150	1,745	360	2,831	936	362	2,571	871	370	-	-	-	-	-	-	10,552	3,552	363
1984/85	5,619	2,098	383	2,887	1,054	387	2,849	1,074	402	-	-	-	-	-	-	11,355	4,226	389

Source : Agricultural Economic Division

2-3-3 Export of Thai Maize

According to the FAO (Foods and Agriculture Organization, United Nations) statistics (1984), the world production of maize is about 450 million tons, more than 40% of which is produced in the U.S.A. Thai production amounts only to about 0.9% of the total, namely 4.2 million tons. However, the quantity of exported maize from Thailand shares about 4.5% of the total international trade quantity, which ranks Thailand in 4th position after the U.S.A., Argentina and France.

Such a high ranking for Thailand in the world maize exporting market is based on its higher export proportion of maize production. In other words, most of maize produced in Thailand is exported because maize is not in high demand domestically for foods, compared with other major producing countries.

Thai maize was largely exported to Japan by the latter half of the 1960s. Since then, the export market for Thai maize has steadily spread to other Asian countries such as Taiwan, Singapore and Hong Kong, the Middle and Near East areas including Kuwait, Saudi Arabia and many parts of African countries.

Major Maize Export Country (1984)

Country	Export Q'ty (1,000ton)
U. S. A.	49,114
Argentina	5,518
France	5,208
Thailand	3,117
Belgium, Lux	1,501
Yugoslavia	685
People's Rep of China	520
Romania	500
Zimbabwe	500
Canada	499
World	68,848

Source: FAO Monthly Bulletin of Statistics

Maize Domestic Consumption and Export of Thailand

Unit : Ton

Year	Domestic Consumption	Export(Fiscal Year)
1976	286,817	2,301,356 (1976/77)
1977	159,122	1,183,442 (1977/78)
1978	836,422	1,962,401 (1978/79)
1979	874,850	1,877,530 (1979/80)
1980	822,669	1,838,242 (1980/81)
1981	901,584	2,800,955 (1981/82)
1982	200,758	1,815,790 (1982/83)
1983	921,955	2,889,628 (1983/84)
1984	1,109,517	2,898,148 (1984/85)

Source : Ministry Agriculture and Cooperative
JETRO

2-3-4 Export of Thai Maize to Japan

The regular export of Thai maize to Japan was started by the first Maize Agreement between Japan and Thailand executed in 1959.

The quantity of export has increased year after year, and in 1975 a maximum of 952,000 tons was recorded. However, the agreement was temporarily suspended because of a disagreement in quality, price and loading conditions, etc., by a final export of 311,000 tons based on the 21st pact in 1979.

The matter of quality encountered at the beginning of export concerned high moisture content, mixture of damaged grains and other failures to meet quality specifications. Furthermore, the cargo was sweat damaged during shipment because of the high moisture content and high temperature in the grains after loading. These problems have been gradually solved by regulating silos in exporting ports. However, since 1981 the contamination of aflatoxin in Thai maize has become a barrier to trade and export to Japan has more difficult.

As described above, export to Japan was substantially suspended for several years. In 1985, the Thai government revealed a strong intention to resume export of maize to Japan, since some quantities of maize could pass the international quality standards. As of May, 1986, an amount of about 70 thousand tons was exported to Japan with control of maize quality against aflatoxin contamination at the time of shipments.

Thai Maize Export to Japan

Unit : Ton

Year (July-June)	Production (A)	Export (B)	Export to Japan (C)	(C)/(B)
1959/60	317,200	236,000	191,530	81.2%
1960/61	534,900	521,592	446,295	85.6
1961/62	598,300	59,098	391,764	65.4
1962/63	665,400	725,403	427,803	59.0
1963/64	857,700	926,864	578,961	62.5
1964/65	935,100	862,490	686,420	79.6
1965/66	1,021,300	1,130,277	755,269	66.8
1966/67	1,122,400	1,158,422	760,933	65.6
1967/68	1,314,900	1,245,289	617,440	49.6
1968/69	1,507,500	1,273,793	432,891	34.0
1969/70	1,700,000	1,448,084	548,513	37.9
1970/71	1,938,200	1,635,265	846,557	51.8
1971/72	2,300,000	2,053,211	932,255	45.4
1972/73	1,315,000	975,999	370,120	37.9
1973/74	2,300,000	1,975,900	876,538	44.4
1974/75	2,550,000	1,871,851	781,444	41.7
1975/76	3,000,000	2,258,042	952,431	42.2
1976/77	2,750,000	2,301,356	653,656	28.4
1977/78	1,750,000	1,183,442	322,202	27.2
1978/79	3,030,000	1,962,401	718,769	36.6
1979/80	2,863,200	1,877,530	310,892	16.6
1980/81	2,997,800	1,838,242	3,115＊	—
1981/82	3,448,500	2,800,955	205,790	7.3
1982/83	3,002,000	1,815,790	7,730＊	—
1983/84	3,552,000	2,889,628	9,137＊	—
1984/85	4,226,000	2,898,148	7,318＊	—

Source: JETRO

＊ Feed for pigeon

2-3-5 Domestic Demand of Thai Maize

The domestic demand for maize in Thailand has significantly increased recently. According to an estimated figure for 1973/'74, the demand was 341 thousand tons. However, the figures have been increasing 10% per year in the past 10 years; about 950 thousand tons in 1978/'79 and about 1.5 million tons in 1984/'85. Most domestic consumption is as feedstuff for the broiler industry which is growing rapidly.

2-3-6 Prospects of Thai Maize

Production forecast for Thai maize will be summarized by the following aspects:

- Possibility for expanding planted area
- Possibility for increasing production quantity per unit planted area

Regarding "new land exploitation", the land law issued in 1959 regulated granting land ownership to the farmers. In consequence, the lands have been exploited by many farmers deep into the interior. However, it is generally understood that the expansion of planting areas is now confronted with a limit.

In respect to the possibility for increasing production quantity per unit planted area, various efforts have been made, including the introduction of superior varieties, fertilization, weed control, etc. However, these efforts will not yield satisfactory results very early because of the irregular weather and socioeconomical constraints in Thailand.

In considering these circumstances, maize production in Thailand will not grow as fast as before, but is expected to remain at a production level of 4.5 - 5 million tons for the time being. However, many experts employed in the maize industry in Thailand point out that "Even if the production volume of maize increases, the sales to overseas countries will be limited unless the matter of aflatoxin contamination is solved, thereby depressing the price of maize."

2-4 Processing and Marketing of Maize after Harvest

The marketing route of Thai maize is briefly described in the following.

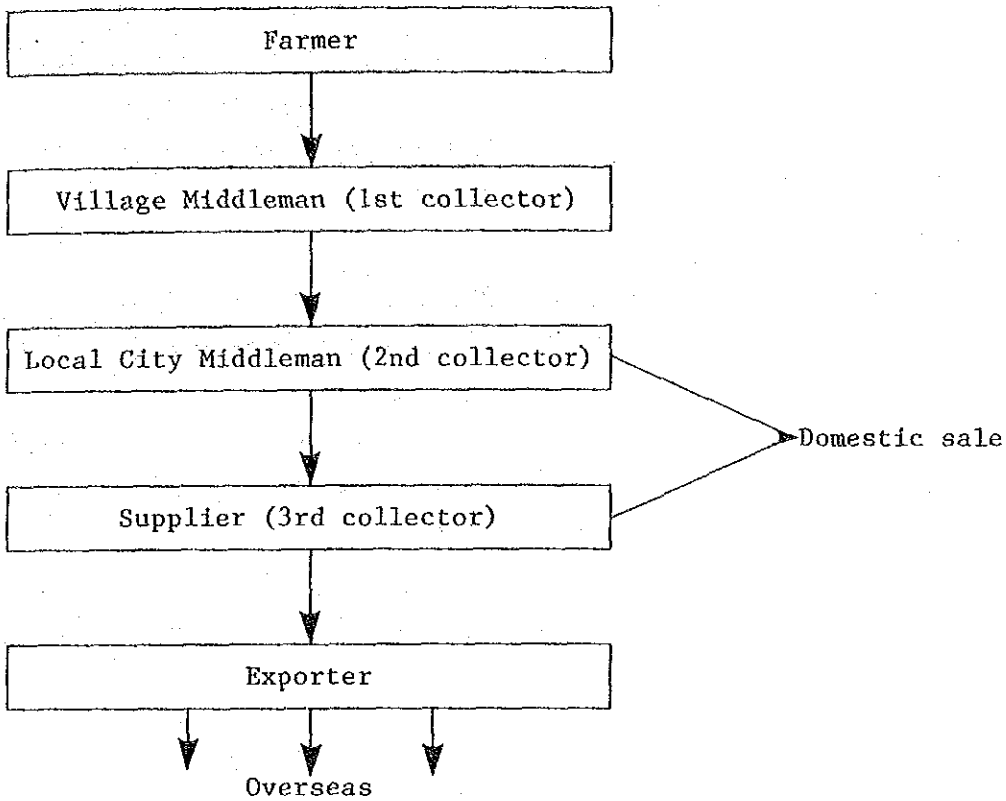
First, the first collector, a village middleman, buys maize from producer farmers. The village middleman lives in a producing village or Muban, many also dealing with miscellaneous commodities and crops. The village middleman lends seeds, agricultural chemicals, tractors and other tools to the farmers and occasionally instructs the farmers on production techniques, thereby he is deeply concerned in farming operations.

Maize, bought by the village middleman, is sold to the secondary collector, a local city middleman. The middleman usually deals with miscellaneous commodities and crops in cities such as Lopburi, Saraburi and Nakhon Sawan. The local city middleman, acting as a wholesaler, trades his maize with suppliers and exporters by referring to the market price in Bangkok. Recently, many local city middlemen maintained warehouses (Godown) with the intention of more advantageously dealing with maize according to market prices.

The general structure of the marketing route from farmers to exporting port, as described above, is a rather conventional system. However, the system has gradually fallen apart. The conventional route of the farmers - village middleman - local city middleman - supplier - exporter - has been modified to include various new routes such as direct sales to the local city middleman from the farmers. This bypasses the village middleman. Direct sales from the local city middleman to the exporter bypasses the supplier and direct sales from the village middleman to the exporter bypasses the local city middleman and supplier.

It should be noted that the step between the village middleman and the local city middleman acts as a reservoir in which the warehouse is retained for stocking maize to control selling according to the market price in Bangkok. As a consequence, maize marketing in Thailand has become more complicated because speculations, mainly done in the supplier levels before, are now prevalent in producing areas.

Structure of Marketing of Maize



Within the marketing system above, various post-harvest processing works are carried out, including shelling, drying, storage and transportation, etc.

Farmer stage

Maize cobs are sold to the 1st collector at harvesting yard or from farmer's garden without drying.

1st collector

The cobs containing high moisture are shelled using tractor driven corn shellers.

2nd collector

Buys maize grain in bulk. A portion of the maize is dried in the sunshine at his own drying yard. However, most of the maize is delivered to export silos retained by the exporters at

Bangkok or Tarua through suppliers (3rd collector), and is still in a high moistured state.

Exporter

Maize, as bought, (moisture content 22% - 18% in the rainy season, and 18% - 16% in the dry season) is dried to meet export specifications of 14.5% in the large dryers and is then stored in the silos.

Various governmental or public organizations such as the Agriculture Cooperative Federation of Thailand, Bank for Agriculture and Agricultural Cooperatives and Marketing Organization for Farmers have tried to buy maize directly from the farmers as a governmental policy for supporting the farmers. However, the results obtained so far are not satisfactory because the maize quickly deteriorates due to high moisture content.

2-5 Aflatoxin and its Contamination of Thai Maize

2-5-1 Outline of Aflatoxin

Aflatoxin is the name given to an extremely toxic group of metabolites produced by the moulds Aspergillus flavus and Aspergillus parasiticus under conditions of high temperature and humidity. The moulds grow on all food and feedstuffs, but particularly on maize, oilseeds and edible nuts. Aflatoxin contamination of animal feed can lead to high levels of animal mortality or to impaired food conversion efficiency - depending upon the level of contamination.

(1) Type of Aflatoxin

The types of aflatoxin are B1, B2, G1, G2, M1, M2. Aflatoxin B will give the fluroescent reaction to blue light and aflatoxin G will give the fluorescent reaction to green light. Aflatoxin B1, the most toxic and also the most prevalent of the toxins, is the most potent chemical carcinogen known to man and has been shown to cause liver cancer. The types of M are found in the milk and urine of animals whose feed contained aflatoxin.

(2) Environment

1) Temperature : Fungus can grow in the range of 6-46°C but the optimum range of temperature is at 25-35°C.

2) Relative humidity : The suitable relative humidity for fungus growth is at about 85%.

3) Light : Light will activate fungus to produce a high level of toxin in a shorter period of time.

4) Oxygen and Carbondioxide : Both of them are necessary for fungus respiration

5) Time : In a suitable environment, fungus can produce the toxin within 24 hours.

(3) Physical and Chemical Property

1) Dissolve in Lipid, Oil and Sodium chloride solution.

2) Tolerant with air of 200°C of temperature extreme.

3) Easy to destroy in alkaline solution such as Hydrogen Peroxide and Sodium Hypochloride.

4) Analytical methodology is capable of detecting aflatoxins down to levels of about 1 part per billion (1 ppb or 1 microgramme per kilogramme). Problems of sampling are recognized to be of crucial importance in attempts to control contamination of non-homogeneous lots of foods and feeds.

(4) The Limitation of Aflatoxin Content

The maximum level of aflatoxin content in agricultural products that are used for human and animal consumption have different limits in

each country. In the United State of America, the maximum limit of aflatoxin content is not to exceed 20 ppb for human consumption products and not exceeding 100 ppb was animal feed. The guidelines of the world Health Organization (WHO) for human consumption product are not to exceed 30 ppb.

2-5-2 Contamination of Thai Maize with Aflatoxin

It is generally understood that, in Thailand, maize is contaminated with aflatoxin to a mean of about 100 ppb, much larger than the international allowance of 30 ppb. FAO/WHO has proposed a guideline of 30 ppb as a maximum content of aflatoxin in foodstuff.

Such a high contamination may caused by the fact that maize is planted at the beginning of the rainy season. Although the maize matures after 110 - 120 days, it is still the end of the rainy season. Therefore, harvesting and processing, namely drying, shelling, cleaning, storage and transportation are carried out ineffectively in high-temperature and high-humidity environments.

In fact, most farmers do not possess machinery needed for post-harvesting works, especially dryers, shelling machines and storage sheds. After shelling, wet maize is delivered into port silos provided with large drying machines, located near Bangkok and Tarua. For example, wet maize containing about 24% moisture, after being harvested, and shelled, is delivered to the port silos after spending several days from the production area. Most of the maize, upon arriving at the silos, is thus heated up by respiratory heat. In the extreme, a strong, obnoxious odor of decay is emitted. It is easily observed in these circumstances that the maize is infested with fungus Aspergillus flavus which yields aflatoxin.

The table on the next page shows the contamination of Thai maize with aflatoxin upon shipments.

Much aflatoxin contamination is caused by improper handling after harvesting. Therefore, post-havest processes and the causes of aflatoxin contamination will be outlined in the following.

(1) Harvesting Process

1) When harvesting maize, not only matured but also prematured maize cobs are simultaneously collected at the same time.

Reasons:

a. Non-uniform growing plants result in irregular maturity even in the same field.

b. Harvesting is often done depending on the price of maize, even it is premature.

c. The hereditary nature of seeds is not uniform, including maturity periods.

2) Bamboo or steel knives are used during harvesting work for shucking which scratches maize grains during harvest.

3) Maize cobs, after harvesting, are left undried in the field or around farmer's houses until collected by village middleman.

Thai Maize Aflatoxin B1 Contamination
(Pre-Loading and Loading Sample)

Year/Month	No.of Sample	Aflatoxin B1 (ppb)							
		≦20	21～30	31～50	51～80	81～100	100<	Ave.	Range
'85 July	13	3	5	1	1	0	3	55	10～209
Aug.	12	3	4	1	2	0	2	45	2～108
Sep.	78	5	10	12	17	5	29	91	12～343
Oct.	86	5	6	12	17	13	33	97	5～305
Nov.	197	24	18	35	25	23	72	99	0～551
Dec.	102	24	10	24	14	10	20	59	0～220
'86 Jan.	119	56	20	15	12	4	12	36	0～212
Feb.	164	63	23	26	25	9	18	45	0～360
Mar.	245	111	25	32	45	16	16	40	0～205
Total	1,016	294	121	158	158	80	205		
(%)	(100)	(28.9)	(11.9)	(15.6)	(15.6)	(7.9)	(20.1)		

Source: OMIC

(2) Shelling Process

1) Most harvested cobs are not dried before shelling (moisture content 28% - 22% in the rainy season and 24% - 18% in the dry season).

2) Shelling machines in use are mostly driven by farm tractors, having excess power in general. In addition, the machines are roughly operated, leaving scratches on the surface of the maize grains during shelling work. The phenomena occurs with premature grains in particular.

(3) Drying Process

1) Maize cobs are very rarely dried by the farmers before collection by collectors in the village level.

2) The collectors do not dry maize in general except the maize stored by themselves. They resell to the 2nd collectors who transport the maize long distances.

3) When the 1st collector dries the maize, the moisture content limit after drying is about 18%, a critical moisture content for short-term storage instead of a safe moisture content against fungus infestation.

4) Most drying yards possessed by the 1st and 2nd collectors in the production districts are wide areas of concrete in which maize grain is spread for sun drying.
At that time, the maize is often moistened again by showers, etc. Even if there are no showers, some of the maize scattered in the drying yard, will result in rotted grains which are often mixed into sound maize lots.

5) Recently, storage facilities equipped with modern drying machines have been constructed in the production areas. However, the quantity of maize dried by these facilities is a very small fraction against the total volume.

6) Most maize for export shipment is dried in silos located at the exporting ports. The large drying machines (processing 50 - 80 tons per hour at a moisture reduction rate of about 5%) are operated to handle the large quantity of maize delivered at a moisture content of about 20 - 25% in the rainy season and about 18% in average even in the dry season.

(4) Cleaning Process

1) Shelling work also serves for cleaning. Consequently, most maize is not particularly cleaned.

2) Damaged grains are very rarely cleaned (heat damaged grains - created during storage, damaged grains - created by a mold in the processes after harvest).

(5) Transportation System

1) In the production areas, small trucks (2 - 4 ton type) are mostly used. For long-distance transportation from the production areas to export ports, large trucks (8 - 10 ton type) or barges (100 - 200 ton type) are used for transportation.

2) About 80% of the maize is transported in bulk, while the balance about 20%, is packed in bags.

3) The number of days spent in transportation depends on the distance. In trucking transportation, maize is transported for an average of 2 days from Nakhon Sawan or Nakhonrachashima and 2 - 3 days from Phetchabun and Khon Kaen to the export ports. With a barge, the number of transportation days is normally longer, during which time high-moisture maize sometimes deteriorates.

(6) Storage Practice

1) It is not common for farmers to store maize cobs or maize grain.

2) The 1st collectors sometimes store maize of about 20 - 50 tons in short term (10 days - 20 days). Even when the collector stores maize, the moisture content of maize cannot be completely dried due to rainy weather, only enough to withstand storage for 1 - 3 weeks.

3) The 2nd collector often stores a lot of 50 tons - 300 tons in his own drying yard after sun drying maize. Such maize is stored for a rather long time (1 - 3 months). However, the facilities are very poor. Maize, thus stored, is shipped after March but generally contains much aflatoxin.

4) Exporters retain silos, in the port area of Bangkok and Tarua, having a total storage silo capacity of about 1 million tons. These silos are equipped with large drying facilities, which can dry wet maize to be delivered. Most of these silos are also provided with moisture sensors which can be used for quality control by detecting heat generation during storage. However, very few silos can be ventilated during storage as per modernized facilities.

2-6 Governmental Measures to Combat Aflatoxin Contamination

2-6-1 Committee to Solve the Problem of Toxic Substances in Agricultural Products

The Ministry of Agriculture and Cooperatives has long been interested in the matter of aflatoxin contamination in crops. Recently, the Ministry became aware of the fatal effect of the contamination on overseas exports, in which the production of the farmers would be depressed. In addition, the Ministry noted that Thai maize might be shut out of major export markets. Therefore, the Ministry created a list of relevant governmental organizations and private sectors to organize powerful

members from a wide range. The list was proposed to the Secretary of the Prime Minister asking for approval by a cabinet meeting.

In response to the proposal of the Ministry of Agriculture and Cooperatives, the Deputy Secretary-general to the Prime Minister sent a letter on August 8, 1985 to the Secretariat of the Ministry of Agriculture and Cooperatives, stating that the formation of the committee, proposed to the Ministry to Mr. Bhichai Rattakul, H.E. Deputy Prime Minister, was accepted by the cabinet meeting. In addition, the letter also described that further proceedings are required.

The list of committee members includes a wide range of sectors such as Ministry of Agriculture and Cooperatives, Ministry of Commerce, Office of the National Economic and Social Development Board, Board of Trade of Thailand, Thai Maize and Produce Traders Association and Kasetsart University, as shown below.

Chairman	Deputy Minister, Ministry of Agriculture and Cooperatives (Mr. Barom Tahthien)
Vice Chairman	Permanent Secretary for Ministry of Agriculture and Cooperatives
Vice Chairman	Permanent Secretary for Ministry of Commerce
Member	Director-General, Department of Agriculture
Member	Director-General, Department of Agricultural Extension
Member	Director-General, the Cooperatives Promotion Department
Member	Secretary-General, Office of Agriculture Economics
Member	Managing Director, Bank for Agriculture and Agricultural Cooperatives
Member	Inspectors-General, Ministry of Agriculture and Cooperatives
Member	Secretary-General, Office of the National Economic and Social Development Board
Member	Director-General, Department of Foreign Trade
Member	President, Board of Trade of Thailand
Member	Chairman, Thai Maize and Produce Traders Association

Member	Mr. Wathitep Nantapiwat, Thai Maize and Produce Traders Association
Member	Rector, Kasetsart University
Member and Secretary	Dr. Tanongchit Wongsiri, Deputy Director-General, Department of Agriculture
Member and Asst. Secretary	Mrs. Dara Buangsuwon, Plant pathologist, Department of Agriculture

In addition, the following 3 Sub-Committees have been organized under the Committee.

1) Sub-Committee on Research and Development
2) Sub-Committee on Extension
3) Sub-Committee on Marketing

2-6-2 Practical Measures to Solve Aflatoxin Contamination

Under the guidance of the "Committee to Solve the Problem of Toxic Substances in Agricultural Products", the government decided to perform the following activities in the fields of research and development, extension and marketing jointly with relevant governmental organizations, universities, public corporations and the private sector to solve toxic fungus problems, particularly aflatoxin contamination.

1) Sub-Committee on Research and Development

Short-term strategies

a) To develop effective and simple driers to be used in production areas.

b) To develop chemical detoxification for aflatoxin.

c) To establish methods of sampling and analyzing (particularly simplified methods) for aflatoxin and to train those operators.

Long-term strategies

a) To comprehensively study methods of cultivation for harvest during the dry season.

b) To develop new varieties having resistance to aflatoxin contamination.

c) Basic study on Aspergillus flavus fungus.

2) Sub-Committee on Extention

a) To reinforce and improve PR and advertising activities.

b) To train and educate in preventive technology.

c) To set up a model firm for improving cultivation and post-harvest practices and apply the results widely.

d) To appraise the improvement and select the most effective improvement methods by monitoring the results of the above.

3) Sub-Committee on Marketing

a) To set up price differences depending on maize qualities.

b) Recommendation for traders of maize to equip themselves with moisture detectors.

c) To regulate for the provision of aflatoxin analyzers in those facilities dealing with large quantities of maize such as export silos and feed manufacturers.

d) To gather information on aflatoxin both domestic and overseas.

Among these actions, the sub-committee on marketing presently places particular emphasis on "to set up price differences depending on maize qualities" and "to regulate for the provision of aflatoxin analyzers in the facilities dealing with large quantities of maize such as export silos, feed manufacturers". These have been gradually introduced for the crops produced in 1985/'86 with a considerable effect.

However, no effective measures have been applied yet in R/D and extension, partially because of financial limitations.

2-6-3 Plan for Establishing of an Institute

The Thai government has been planning to establish an institute for studying how to prevent aflatoxin contamination of maize, which will work in the following activities.

(1) Introduction of Modern Technology for Analysis

The contamination can be studied and analyzed, while establishing the methods for analysis and detection. In addition, peripheral technology can also be improved, such as cultivation, inoculation, observation, etc. of aflatoxic fungus.

(2) Clarification of Actual Status of Contamination

The present status of contamination and the catching root and degree of aflatoxin contamination can be precisely studied to analyze the causes and mechanism of the contamination in the processes of maize production, post-harvest processing (drying, shelling, cleaning) and marketing (storage, transportation).

(3) Establishing Prevention of Contamination

The most effective and practical methods of preventing aflatoxin contamination will be proposed through studying and analyzing the biological conditions of the aflatoxin producing fungus, actual status of contamination and its mechanism.

However, such a proposal for establishing of an institute has not been realized at present because of the heavy financial burden to the Thai government.

2-7 Organization, Functions and Budget of the Ministry of Agriculture and Cooperatives

2-7-1 Ministry of Agriculture and Cooperatives

The Ministry of Agriculture and Cooperatives has been organized by merging the former Ministry of Agriculture and the agriculture related Departments of the Ministry of Land Development, in November, 1972.

The Ministry of Agriculture and Cooperatives governs matters related to agriculture, while covering a scope of basic arrangement, production technology, extension and cooperatives activities. As such, the Ministry of Agriculture and Cooperatives controls the production of agricultural products. On the other hand, the processing of agricultural products is governed by the Ministry of Industry while the Ministry of Commerce controls the marketing of the products.

The annual budget of the Ministry in 1984/'85 was about BHT21.8 billion (about ¥160 billion). The organization is shown in the attached chart of the Ministry of Agriculture and Cooperatives.

Among other departments, the following 3 departments are concerned in the production of maize.

Department of Agriculture
Department of Cooperatives Promotion
Department of Agricultural Extension

2-7-2 Department of Agriculture and Relevant Divisions

Out of the foregoing 3 Departments, the Department of Agriculture is in charge of dealing with the plan.

The Department of Agriculture has been organized by merging the former Rice Department and Agricultural Department in the previous reorganization. A Director-General controls the Department, with the assistance of Deputy Director-Generals in charge of administration and finance, investigation and technology, covering, as shown in the attached data, a total of 18 sub-sections including offices, divisions and institutes.

The routine work of the Ministry includes plant quarantine and general jobs for regulating fertilizers and agricultural chemicals. The annual budget for the Department in 1984/'85 amounted to about BHT800 million (about ¥6 billion).

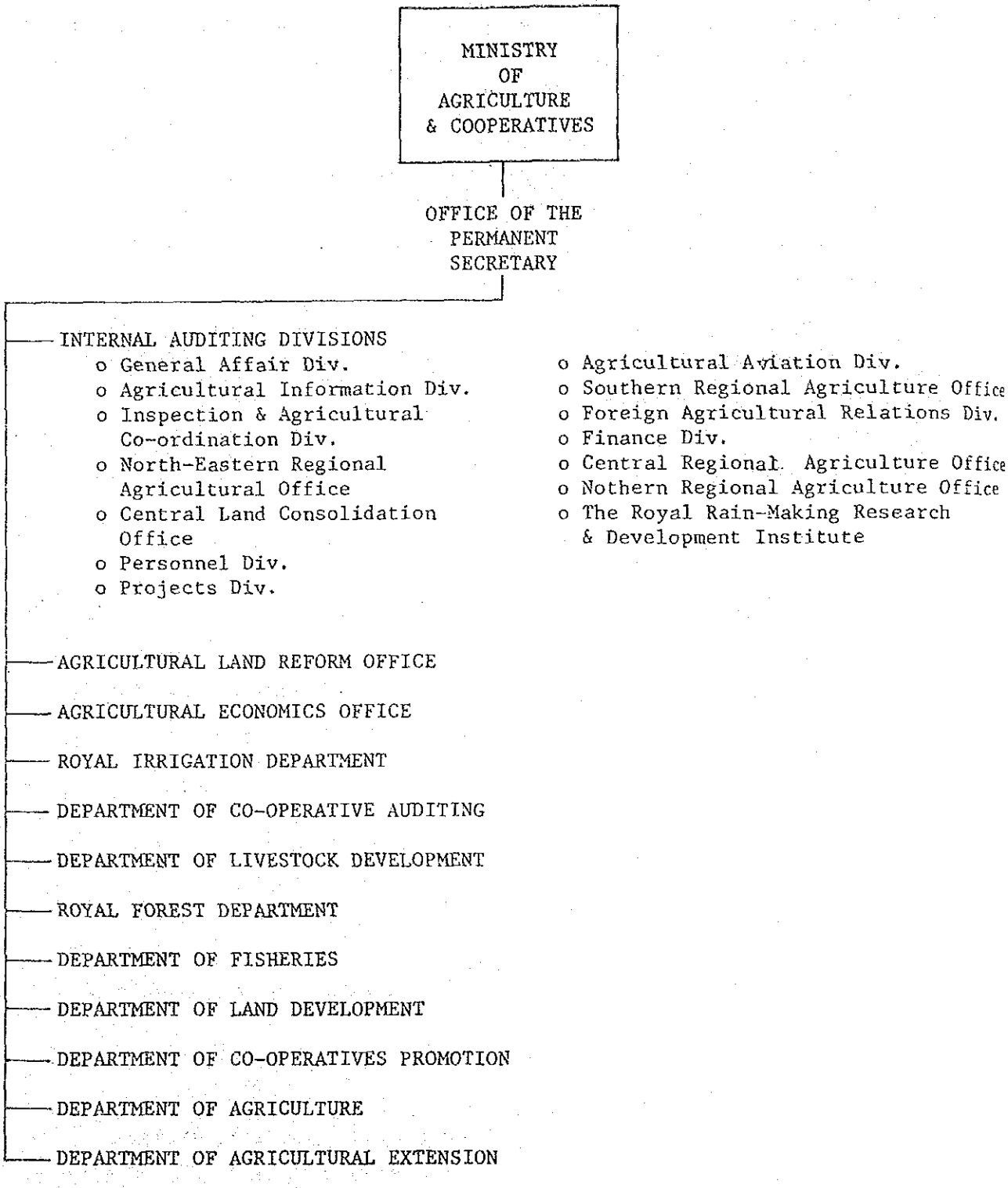
The following divisions and institutes are particularly related to the plan as outlined below.

(1) Plant Pathology and Microbiology Division

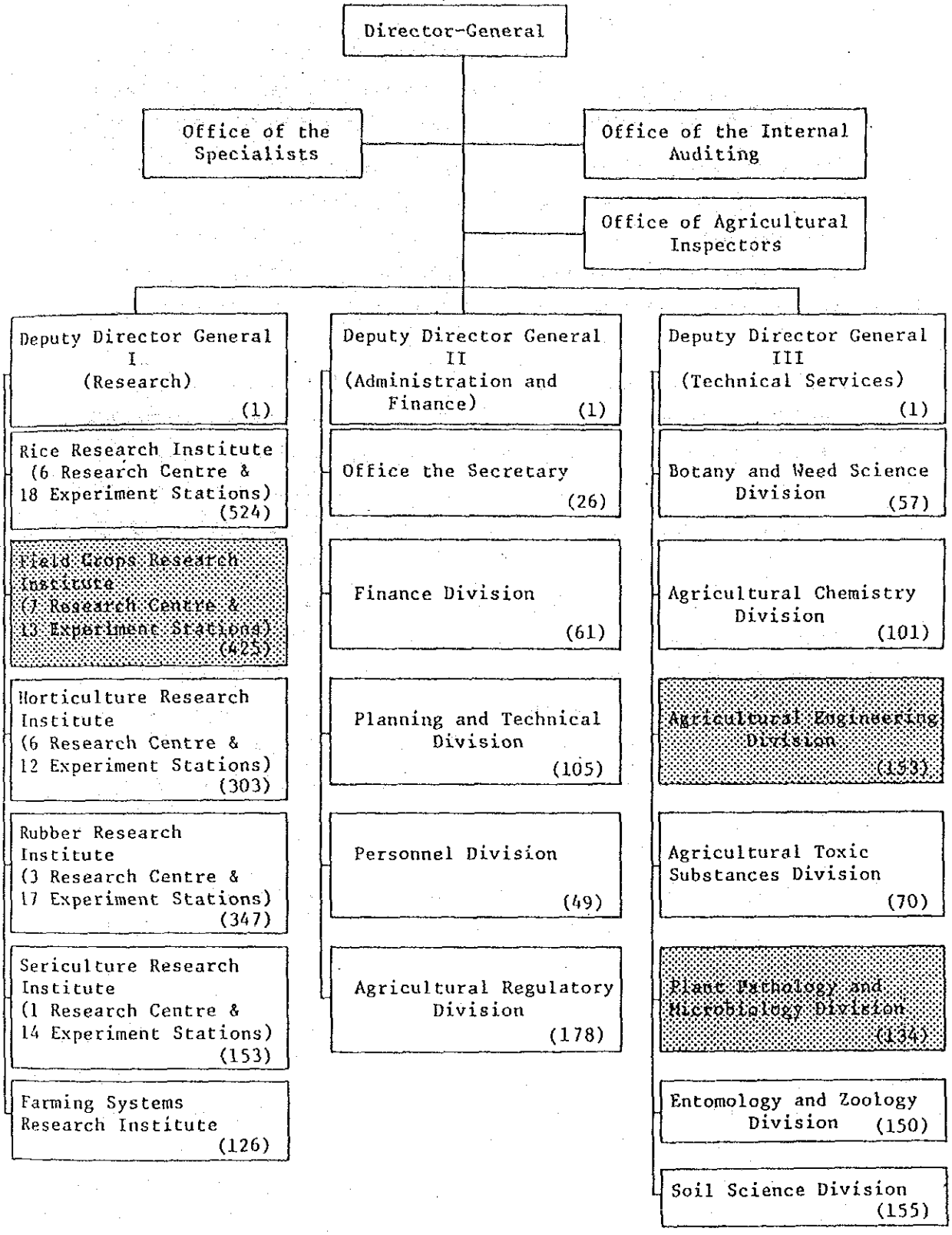
The division in charge of testing and studying the subjects belonging to plant pathology and microbiology. The division is operated with 12 sections together with an administrative office.

The Seed and Post-harvest Pathology Section is directly concerned in the plan and managed by Mrs. Dara Buangsuwon, a representative for the division.

Organization of Ministry of Agriculture and Cooperatives



Organization of Department of Agriculture



Note: Figures in ( ) shows the numbers of personnel.

Sited from: Preliminary report for Thai maize quality improvement, International Cooperation Business Organization

(2) Agricultural Engineering Division

The division develops and introduces machinery suitable for Thai farmers, and trains young farmers in the operation of the machinery. For such purposes, the Agricultural Engineering Division carried out the tests and researches for developing, improving, training and exercising agricultural machinery. In addition, the maintenance and control services for the machinery are also performed by the division. The division consists of 6 sections including the administration office.

The storage and processing research section is directly related to the plan, and managed by Mrs. Sriwai Singhagajen, a representative of the division for the plan.

(3) Field Crops Research Institute

The institute is in charge of the studies for field crops. The institute also carries out seed breeding jobs such as the distribution of improved seeds and extension of new technology in cooperation with the Department of Agricultural Extension and the Department of Cooperatives promotion. The Institute is separated into, the Central Unit in Bangkok and the Regional Unit for the activities with respective crops.

A. Field Crops Research Institute (Central Unit)

1) Group of Crop Specialist
2) Monitoring & Evaluation Section
3) Training Section

B. Field Crops Research Centers and Stations (Regional Unit)

1) Chainat, FCRC	Green beans and other irrigated crops
2) Chieng Mai, FCRC	Soy beans, baby corn

3)	Khon Kaen, FCRC	Peanut, Kenafe
4)	Nakhon Sawan, FCRC	Maize, cotton
5)	Rayon, FCRC	Cassava
6)	Suphan Buri, FCRC	Sugar cane, Sorghum
7)	Ubon Ratchathani, FCRC	Castor bean, sesame and other rain fed crops

Field Crops Research Institute in the Central Unit is particularly concerned with this Project. Mr. Narongsak Senanarong, of the Group of Crop Specialist, is in charge of coordination.

The Nakhon Sawan Field Crops Research Center located is particularly interested in carrying out the study and survey on maize. Three Experimental Stations (ES) are organized under the control of the Center. The following 4 test fields are located in the maize production areas.

Nakhon Sawan, FCRC

- Banmaisemrong, FCES
- Phra Phutthabat, FCES
- Petchabun, FCES

Tests and experiments, to be performed in respect to the cultivation of the Plan, would be carried out mainly in Phra Phutthabat, among the 4 test fields above. Reasons are as follows:

1) In "The Technical Cooperation Project on Maize Development in Thailand" 1977-1984, promoted and executed by Japanese assistance, the part of operations allocated to the Department of Agriculture, was actually executed in the Phra Phutthabat farm to which a lot of machinery and materials were introduced.

2) It is the nearest to Bangkok (about 2 hour drive)

3) The farm comprises a total area of 200 Rai (32 ha), among which 16 ha is already irrigated.

2-8 Assistance Projects from Overseas Countries for Solving Aflatoxin Contamination

At present, the Thai government receives the following funds and technical assistance from overseas countries for solving aflatoxin contamination of maize.

1) The Tropical Development and Research Institute, U.K. offers engineers and equipment for survey and training. The amount is US$600,000.

2) The U.S.A. provides a soft loan (US$200,000) for buying analyzing instruments and training Thai engineers abroad.

3) The United Nations gives US$38,500 for survey and research.

4) The Japanese Tropical Agriculture Research Center provides assistance with equipment and researchers required for basic survey and research.

Among the above, the U.K. and Japanese projects are highly appreciated by the Thai Government. The cooperations of the U.K. begun in 1984. Its results obtained so far include the investigation of the route of aflatoxin contamination, scope of contamination, introduction of simple analyzing methods and proposal of mechanical drying system.

On the other hand, Japanese assistance is particularly emphasized on the survey of actual contamination, biological analysis of source fungus and development of microbe contamination prevention technology. In particular, the first 2 items have been focused for the time being as a fundamental study, namely the survey of actual contamination and biological analysis of the fungus.

As described above, many foreign countries offer and provide assistance projects for solving aflatoxin contamination. However, local research facilities and machinery are so limited that the assistance cannot bring about comprehensive results yet.

With such a background, the Thai Government have a positive intention to solve the problem as early as possible by providing modern facilities and machinery for the tests and studies.

2-9 Brief Review of Request of the Plan

2-9-1 Brief Review

As described before, the poor quality of maize, especially maize contaminated with aflatoxin, which is a species of micotoxin, has become a fatal problem that depresesses maize export from Thailand.

Aflatoxin contamination was recognized as a critical problem during the period of the Thailand "The Technical Cooperation Project on Maize Development in Thailand" (1977-1984) which was carried out with Japanese assistance.

In August, 1984, the Thai government requested the Japanese government for technical assistance to solve the matter. In February, 1985, The Japan International Cooperation Agency delegated a Contact Mission for clarifying the details of the request.

After the above, the organization held various consultations with relevant authorities and offices for preparing to enter the technical cooperation project aimed at developments for solving aflatoxic content in Thai maize. In September, 1985, a preliminary survey mission was delegated from The Japan International Cooperation Agency.

In response to the above, the Thai government requested the Japanese government to offer a research institute with associated equipment for studying aflatoxin contamination in January, 1986.

2-9-2 Outline of Requested Facilities, Equipment and Materials

The outline of the facilities, equipment and materials requested by the Thai government are as follows.

(1) Research administration

1) Researchers' room 120 m^2

2) Exhibition and PR room 40 m^2

3) Administration room 40 m^2

(2) Tests and experiments

1) Experimental facilities for aflatoxin 615 m^2

Sample storage room, culture medium preparation room, sterilizing room, bio-hazard room, incubation room, microscope room, extraction and purification room, chemical analysis room, thin-layer chromatography room,dark room

2) Growth Chamber 18 m^2 x 3

(3) Drying and storage experiment facilities 400 m^2

(4) Experimental and Research machinery

Low-temperature storage, autoclave, drying sterilizer, incubator, grinder, centrifuge, evaporator, mixer, thin-layer chromatography, liquid chromatography, microscope, etc.

3. CONTENTS OF THE PROJECT

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3-1 Purpose of the Project

The purpose of this Project is to provide research facilities and equipment for conducting basic studies and experiments to improve the quality of maize, laying emphasis on elimination of aflatoxin contamination.

The establishment of such research facilities aims at conducting more comprehensive research and study on aflatoxin contamination and to investigate the status quo of the contamination and its causes. Furthermore, to study the relation between the cultivation, harvesting, processing and marketing practices, and the mechanism of contamination occurrence. It is then planned to improve the quality of the maize by applying the findings in the study to eliminate contamination and by proposing the actual improvement method/means at each stage of the production, processing and marketing of maize.

3-2 Study of Contents of the Requests

After studying of the contents of the Project Request from the Thai government, and discussions with Thai-side, the following basic directions in laying out the plan were settled.

(1) Activities of the Center

Research activities carried out in this Center can be classified into three fields such as microbe/analysis, post-harvest processing/storing and agronomy. Regarding the activities of extension, Department of Agricultural Extension is the responsible organization in the Ministry of Agriculture and Cooperatives and Department of Agriculture supports them in technical field. In this background, the activities of extension in this Center are excluded from the plan.

(2) Facilities and Equipment

Facilities and equipment in each field of microbe/analysis, post-harvest processing/storing are to be established in Bangkhen. As for agronomy, although there is no experimental farm around the construction site, necessary equipment will be stored in the Center. And, they will be moved to research centers or stations belonging to Field Crops Research Institute so that experimental works can be made at any time and place.

Meanwhile, a growth chamber or green house will not be provided for this Project, for there is no need to control the temperature in a tropical climate like Thailand's and it is expensive to control and maintain such facilities.

(3) Organization and Personnel

This Center will be set up so that each field of microbe/analysis and post-harvest processing/storage and agronomy can cooperate with one another.

To save on operational cost, the minimum necessary number of researchers and other personnel will be employed. If various activities are to be developed in this Center in the future, personnel will be dispatched by the relating divisions and sections according to the necessity so that such activities can be fully developed.

(4) Technical Cooperation

The equipment must be properly arranged so that the Japanese Technical Cooperation to be provided in the future may be effectively utilized and that technical assistance may be accepted smoothly.

(5) Outlook for Long-term Project

For the time being, this Center will work on activities to improve the quality of maize, primarily by investigating the status quo

of the aflatoxin contamination and establishing measures to remedying it. However, the hot and humid environment in the tropical climate of Thailand presents the best conditions for propagating microbes, and many agricultural products are infested by mycotoxins. To cope with such situations, the facilities and the equipment to be prepared in accordance with this project must be effective.

3-3 Outline of the Project

3-3-1 Management System

(1) Organization

This Center acts as the organization under direct guidance of the Director-General of the Department of Agriculture of the Ministry of Agriculture and Cooperatives. The construction works of the Center and operation of the research activities of the Center after construction will be carried out under the supervision of the Deputy Director-General of the department.

(See organizational set-up of the Center in the following page.)

The following sections in this Center are to be set up to perform research activities effectively.

1) Planning & Administration

This section is to develope plans and administer their enforcement so that research/development can achieve the highest efficiency with the cooperation of the following three sections.

2) Microbe & Analysis

The section plays a core part in this Center. It analyzes aflatoxins, makes ecological study of fungi, and makes related technological development.

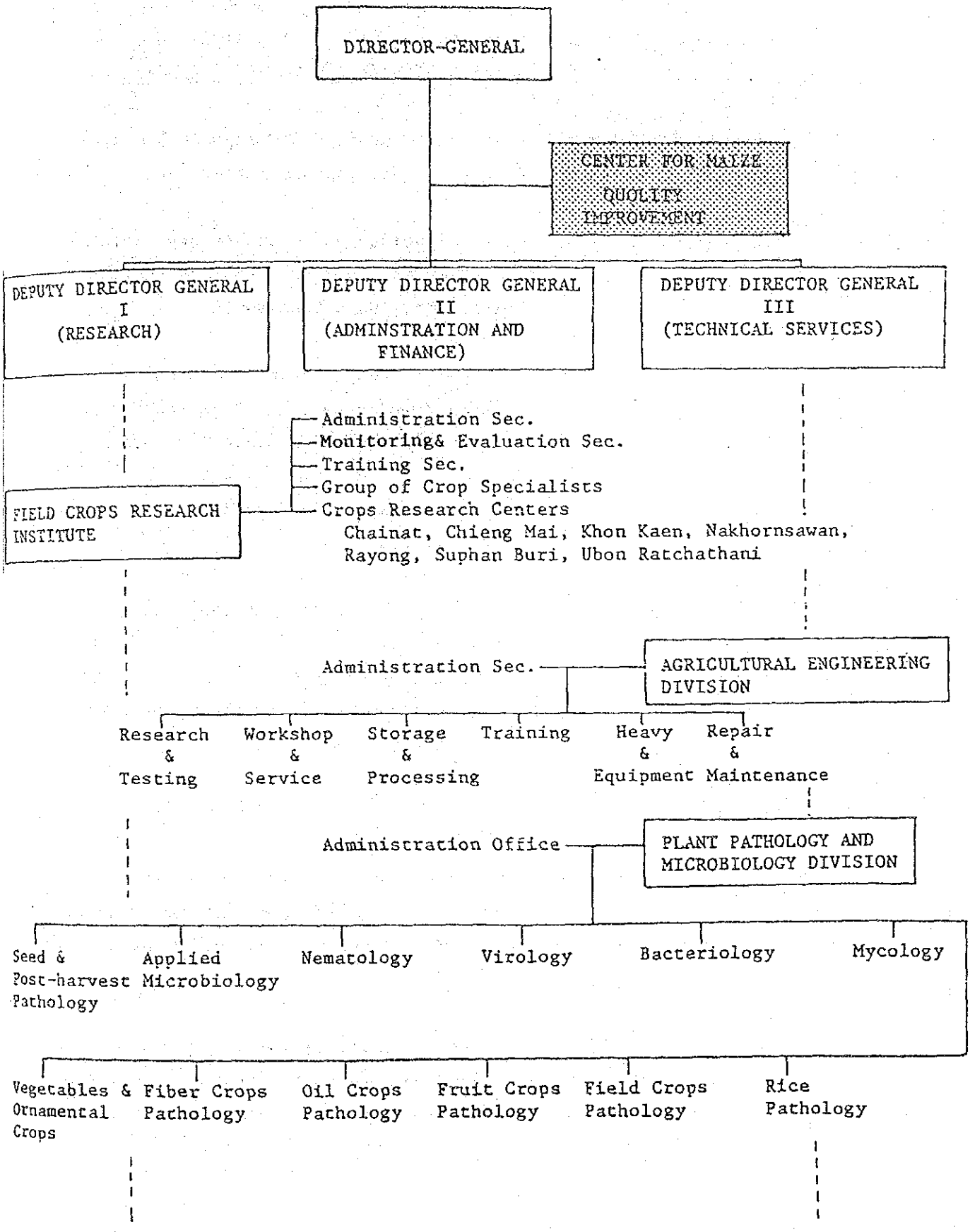
3) Post-harvest processing and storing

The section investigates the cause of aflatoxin contamination in various post-harvesting processings such as drying, shelling, cleaning and storage/transportation. It also inquires into the mechanism and status quo of the contamination to establish a practical improvement method.

4) Agronomy

The section operates experimental tests in fields to eliminate the contamination factors occurring in the growing stage of maize by developing new varieties which have resistance to aflatoxin contamination and by introducing new cultivating systems in which maize can be prevented from aflatoxin contamination.

Position of the Center in the Department of Agriculture



The relation between the above four sections and the existing mechanism is as follows:

The section of the Center	Relation to the existing division or section of the Department of Agriculture
General affairs/ planning	Planning/technology Development Division Director: Mr. Chanuan Ratanwaraha
Microbe/analysis	Plant Pathology and Microbiology Division Seed & Post-harvest Pathology Section Chief: Mrs. Dara Buangsuwon
Post-harvest processing/ storing	Agricultural Engineering Division, Storage and Processing Research Section Chief: Mrs. Sriwai Singhagajen
Agronomy	Field Crops Research Institute Central ... Central Unit Chief: Mr. Narongsak Senanarong Regional ... Nakhon Sawan FCRC (Banmaisamrong, Phra Phutthabat, and Pechabun FCES)

(2) Personnel Planning

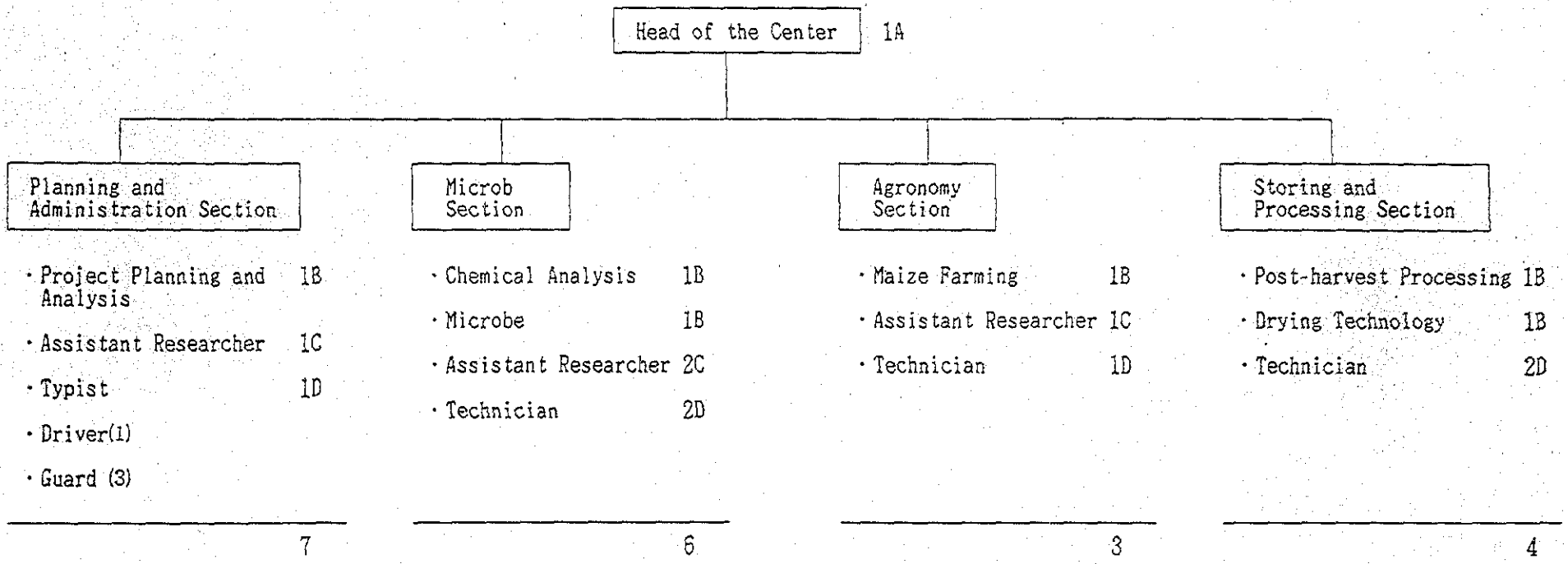
The number of personnel needed for this Center is shown in the attached table. The personnel consist of the minimum required number of Thai researchers, their assistants and other necessary workers

Needless to say, more researchers may be needed depending on the subject of study. Then, Department of Agriculture can arrange personnel assistance by dispatching competent researchers from the related division or section.

Although all the experts of agronomy are positioned at the research centers or stations located in producing districts at present, temporary experts should be positioned at the Center in Bangkhen.

As seen in the table, each researcher must tackle his own subject and the three sections of the Center must cooperate with one another to achieve good results.

Organizational Structure



			Govt. Officer's Grade
Chief of the Center	(A)	1	9
Research Worker	(B)	6	6-7
Assistant Researcher	(C)	4	4-5
Technician	(D)	6	1-3
Others		4	—
Total		21	

3-3-2 Contents of Research Activities

The following activities are to be developed at the Center.

1) The introduction of analyzing methods and the enhancement of the technology level

—— Introduction of up-to-date equipment and technology for analysis of aflatoxin

—— Introduction of up-to-date equipment and technology for making ecological studies such as inoculation and culture

—— Improvement of sampling technology

—— To study the interactive relationship between the quality of maize (moisture content, damaged grain mixing degree) and the aflatoxin contamination

—— Development of a handy and simple method for analysis of the aflatoxin content

—— Development of an accurate and easy method of moisture content of maize

2) To clarify the status quo and the cause of contamination

—— Survey on the contamination according to harvesting time

—— Survey on the contamination according to cultivating districts

—— Survey on the contamination according to varieties

—— Survey on the contamination according to cultivating practice, growth conditions and damage by blight and noxious insects

—— To clarify contamination status and various kinds of work for harvesting/processing and marketing

. Harvesting
. Shelling
. Drying
. Cleaning
. Storing

3) The establishment of a practical method for prevention of aflatoxin contamination

a) Physical elimination (The improvement of post-harvest practices)

—— To improve harvesting practice
—— To improve drying practice
—— To improve shelling practice
—— To carry out cleaning work
—— To improve storing practice

b) Chemical elimination

—— To prevent the propagation of aflatoxin producing fungi by using various gases

—— To control producing fungi by adding various chemicals

c) Biological elimination (Improvement of the cultivating practices)

—— To apply new varieties having resistance to aflatoxin contamination

—— To avoid harvesting in the rainy season

—— To avoid immature cobs in harvesting as much as possible

4) Activities of the Center

The following figure exemplifies various activities in the Center.

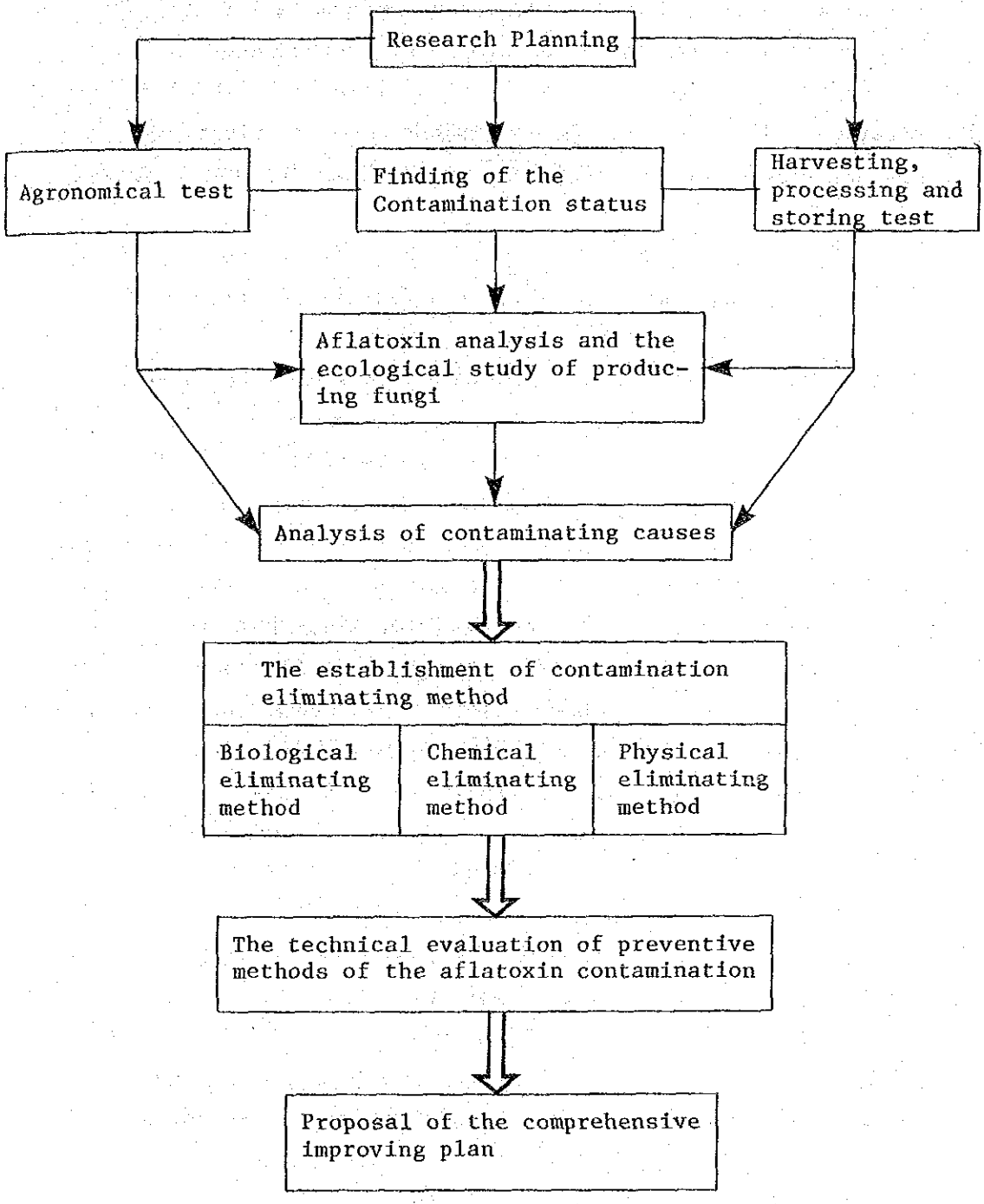


Figure Showing the Activities of "the Proposed Center"

3-3-3 Outline of Facilities and Equipment

The following facilities and equipment will be provided to establish this Center.

(1) Facilities and equipment to analyze various aflatoxins and to make an ecological study on the aflatoxin producing fungi

(2) Experimental facilities and equipment to investigate the cause of contamination and to take measures for post-harvest processing and storing

(3) Equipment necessary to summarize the results of research

(4) Vehicles and experimenting equipment necessary to conduct a field survey in widespread maize-producing districts

In the case of item (1) described above, the laboratory facility must be an independent building, as analysis is made of a very sensitive material which is measured in the units of ppb, namely one billion-th and contains a strong virulence. The facility described in the item (2) should be installed separately from the above-said laboratory building, for much dust is generated when various experiments are made and noises are caused during work. Experimental equipment described in item (3) which are necessary to conduct the field survey will be placed at the Center to be built up at Bangkhen. They will be used at FCRC or FCES in maize producing districts.

Based on the above-mentioned outline, the following experimental rooms and equipment will be provided in this Project.

(1) Equipment to analyze various aflatoxins (G_1G_2, B_1B_2, M_1M_2, etc.) and to make ecological studies of producing fungi

1) Stock Room I

Deep freezer, low-temperature cabinet

2) Sample Preparation Room

Preparation of sample submitted to analysis

Air oven, sample divider, cutting mills, ultra centrifugal mill, sieve

3) Extraction & Purification Room

a) Standard solution processing

Standard solution is resolved and qualified to a suitable concentration.

Shaker set, draft chamber

b) Sample solution processing

Samples extracted from aflatoxins undergo such operations as clean-up, evaporation to dryness and dissolution according to each method of analysis.

Warning blender, shaker, ultra-speed Homogenizer, high-speed centrifuge, column set for purification, PH meter, stirrer, test tube mixer, rotary evaporator, alminum heating block with N_2 gas dry, centrifugal evaporator, draft chamber

4) Analytical Instrument Room

5) Thin-Layer Chromatography Room

High-speed liquid chromatograph set, thin-layer chromatograph set, gas chromatograph set, spectrofluorometer, double-beam spectrophotometer, densitometer, dual-wavelength TLC scanner, chromatoview cabinet, minicolumn detector, desiccator, air

oven, circular cooling water bath, UV lamp, ultrasonic cleaner, draft chamber

6) Culture Medium & Microscopic Sample Preparation Room

a) Processing a medium

Cook top, stirrer, water bath incubator, PH meter, culture medium dispenser, electronic oven, draft chamber

b) Processing microscopic samples

Praffin processer for microscopic sample, paraffin melting oven, paraffin stretcher

7) Bio-hazard Room

Bio bench, safety cabinet, water bath shaking incubator, loop sterilizer

8) Incubation Room

Programmable low-temperature incubator, low-temperature shaking incubator, low-temperature rotary incubator, low-temperature constant-temperature & constant-humidity chamber, water bath circle shaker

9) General Test & Experiment Room

Air oven, moisture tester, Kjeldahl apparatus set, Soxhelt's apparatus set, muffle furnace, vacuum air oven, PH meter, draft chamber

10) Instruments Sterilization & Washing Room

Auto still unit, autoclave, drying sterilizer, air oven, ultrasonic pipette washer, pipette drier, ice machine

11) Balance Room

Precision balance, electronic balance, top-pan balance, beam balance

12) Microscope Room

Microtome, multi-function microscope, vertical microscope, stereo-microscope, photomicrograph apparatus

(2) Equipment and devices to be used for post-harvest processing and storing.

1) Sample Preparation

Probe, sample divider, sieve balance

2) Shelling Experiment

Sheller, dockage tester, test separator

3) Drying Experiment

Test dryer, moisture meter, air flow meter, anemometer, temperature/humidity measuring instrument, platform scale, sample pan, sample basket

4) Storage Experiment

Constant temperature and humidity room, gas analyzer, sprayer, protective closing and gas mask, grain thermometer

5) Work Shop (Wood)

6) Work Shop (Metal)

Maize processing equipment (such as sheller, drying machine and winnowing machine) which meets the requirements of the work site is made on a trial basis and tested.

Saw, circular saw, drill, jig-saw, sander, chisel, plane, engine lathe, shears, spot welder, acetylane welder, electric welder, A.V. meter, vise

(3) Equipment necessary to summarize the results of research

The following equipment is necessary to analyze the results of research quickly and correctly.

a) Personal computer
b) Drafting set
c) Drafting copier
d) Equipment for reporting the results of the research

(4) Vehicles and experimenting equipment for investigating contamination status

On-site study on the state of aflatoxin contamination of maize must be conducted systematically, as one of the important activities of the Center. The survey must be conducted at various times and an adequate number of researchers must be assigned to do it according to objectives. Two kinds of cars will be necessary: one is a small car (ex. jeep) which is capable of running into the backland of the producing districts and is to be used by a small group (2 - 3 persons) and the other is a medium-sized car (ex. mini-bus) which is used by a large group (8 - 12 persons).

Equipment for experimental works for maize cultivation will be 2 items of sprinkler and tractor. They are basically positioned at the Center and moved to Nakhon Sawan FCRC, and its three FCES when necessary. The equipment necessary for experimental works for maize cultivation is as follows:

a) Vehicles for a survey purpose

b) Equipment for investigation and test

- . Probe, double-tube triers
- . Sample divider
- . Sample containing box: A box capable of preserving 40 samples (4 kg) at +5°C
- . Movable sprinkler
- . Tractor

3-3-4 Outline of the Building

(1) Main Building 894.24 m^2

1) Administration section (director's room, meeting room, general office, etc.)

2) Research section (Research room for three related fields and experts, etc.)

3) Experiment section (Aflatoxin experiment rooms including a sample stock room, etc.)

4) Store room

(2) Annex 433.96 m^2

1) Storing and processing section (storage rooms, an experiment room for post-harvest processing and drying, Work shop)

2) Field experiment section (Equipment storage for field survey, etc.)

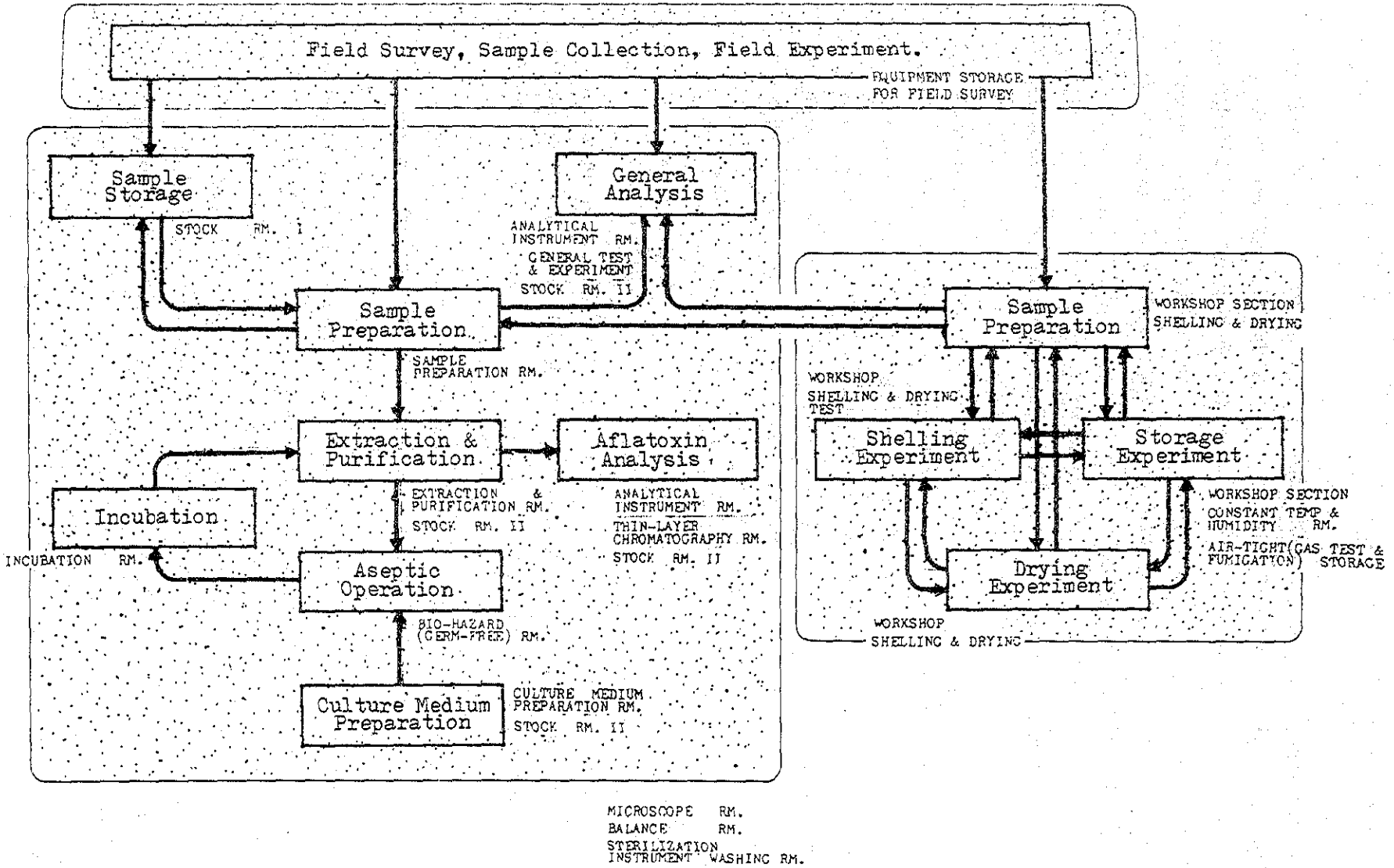
(3) Others 171.81 m^2

1) Generator Rm, Driver's Rm, Stock Rm II, Garage

2) Sun Drying Yard

Total 1,500.01 m^2

As in the results of discussions and from investigation, a growth chamber and some rooms which were included in the facility outline request report presented by the Government of Thailand, have been excluded. However, the Research Rms. for Experts, Equipment Storage for Field Survey, Store Rms., Driver's Rm., and Generator Rm. were added, and as a result, the total floor area increased by 15 percent.



RELATION BETWEEN RESEARCH PROCESS AND EXPERIMENT ROOMS.

3-3-5 Financial Validity

According to the cost estimation, it is expected that the Government of Thailand must bear the cost of 3,835, 800 baht for this Project. Meanwhile, maintenance and operation cost may amount to 6,893,900 baht per year according to the principle that necessary personnel should be minimized and that the maintenance and operation cost of equipment should be also minimized.

These amounts represent only 0.48 percent and 0.86 percent of the whole DOA budget in 1985 respectively.

This Project is one of the most important projects of the various national-level projects planned in Thailand. If the objectives of this Project can be achieved, with such a financial burden, it will prove that such a project is possible.

3-3-6 The Outline of the Project Site

(1) Location

The proposed site is situated within the premise of Department of Agriculture adjacent to the Kasetsart University campus at Bangkhen District in Bangkok.

It is situated halfway between Bangkok and the Don Muang Airport, about a twenty minute car ride from the center of Bangkok. This district is being organized as the central research and administrative district of the Department of Agriculture. The planned candidate site is located in the north where the facilities of the Department of Agriculture are concentrated. The National Animal Health and Production Institute, built as a Japanese Grant Aid Project, and the Rubber Research building belonging to the Department of Agriculture are under construction near the planned site.

(2) Climatic Conditions

Thailand belongs to the tropical monsoon district and it is hot and humid near the proposed site. The annual average temperature is 28.5°C (in 1983), and the sunshine is very strong. In March or April when daylight time is the longest, the sunshine in the morning and evening is also strong. Humidity is very high, between 65 to 85 percent; the average humidity is 74.7 percent. Annual precipitation is about 2,170 mm and it showers for one to two hours everyday during the rainy season (May to October). Wind direction is constant; southwest in February to October and north east from November to January.

(3) Status Quo of the Site

The site is situated to the north of the National Weed Science Research Institute (NWSRI), satisfying the following conditions.

1) The entire site is surrounded by drainage canals, and preventive pumping measures against water disasters (200 m^3/minute) are also provided.

2) Electricity/telephone cables and drains are provided near the site. Urban facilities are relatively self-contained.

3) The boundary lines and the owner (i.e. the Department of Agriculture) can be clearly identified.

4) The size of the site is suitable, compared to that of other institutes.

The site is almost rectangular and its area is about 0.8 ha. It is now used as an experimental field, supervised by the Department of Agriculture. The site is clearly distinguished by roads on two sides and by the concrete irrigation canal on the north side, and the obvious boundary line for the warehouses on the east side. The size of the site is reasonable, with respect to relation to the surrounding research facilities.

(4) Site Preparation

The site is used as a field and the ground surface is about 0.6 m lower than the level of the south front road. Each research institute of the Department of Agriculture and its peripheral facilities are protected by a high bank as a preventive measure against water disasters. After discussion with the officials concerned in the Department of Agriculture, it was decided that the Government of Thailand would carry out the work of filling the land up to a level 1.5 m higher than the current level by taking into consideration the ground level surrounding NWSRI.

(5) Boring Test

The Study Team obtained boring data at three places within the premises of Kasetsart University adjoining the premises of the Department of Agriculture. Judging from the results of the pile construction of the National Animal Health and Production Institute, it seems that the undulations of the ground layer are conspicuous even on the same premises. Therefore, it will be necessary to check the supporting ground with a boring test at the proposed site.

(6) Situation of the Pertinent Infrastructure

1) Electricity:

Two distribution wires, an 11 KV main wire and a 220 V wire, are installed on the boundary between the proposed site and the front road. The low 220 V wire is used for streetlightings on the front road and the warehouses to the east of the premises. It cannot be used for the proposed building.

NWSRI receives power from the 11 KV high-voltage wire (Transformer 150 KVA). The same system was adopted for this proposed facility. Power can be supplied from transformers set up at three places (i.e. electric poles) on the premise boundary. According to the Repair & Maintenance section of the Department of Agriculture power failure occurs two to three times a year,

power failure continues for one to two hours and a voltage drop of about 10 percent is most likely to occur from 6 o'clock to 7 in the evening when maximum electricity is used.

2) Telephone:

Like electrical wires, telephone wires are installed along the boundary on the front road, and there is no need to set up new cables on the premises. Pulling-in into NWSRI is made from the same position as the existing transformers for electricity.

There are no problems concerning the installation of telephones to be used in this plan. Telephones should be installed about three months after application.

3) Water Supply:

Water is supplied to NWSRI in three ways, two wells and the city water piping from the head office of the Department of Agriculture. Each lacks enough capacity for all the buildings in use and cannot be utilized by this project. There is city water piping along drainage canals around the field on the east side, and a 6-inch ϕ installation has been completed by the National Animal Health and Production Institute. They say that, although water pressure differs depending on the time zone, 1 kg/cm^2 has been secured.

The Department of Agriculture is scheduled to set up the piping route as shown on the attached sheet, especially for this project. To prevent damage to the piping, due to ground subsidence and to decrease the piping construction cost, open piping routes will be provided on the field instead of installing them along under the road. It is planned that they will be pulled in to the north east area of the premises. The piping size is 2 inches in ϕ.

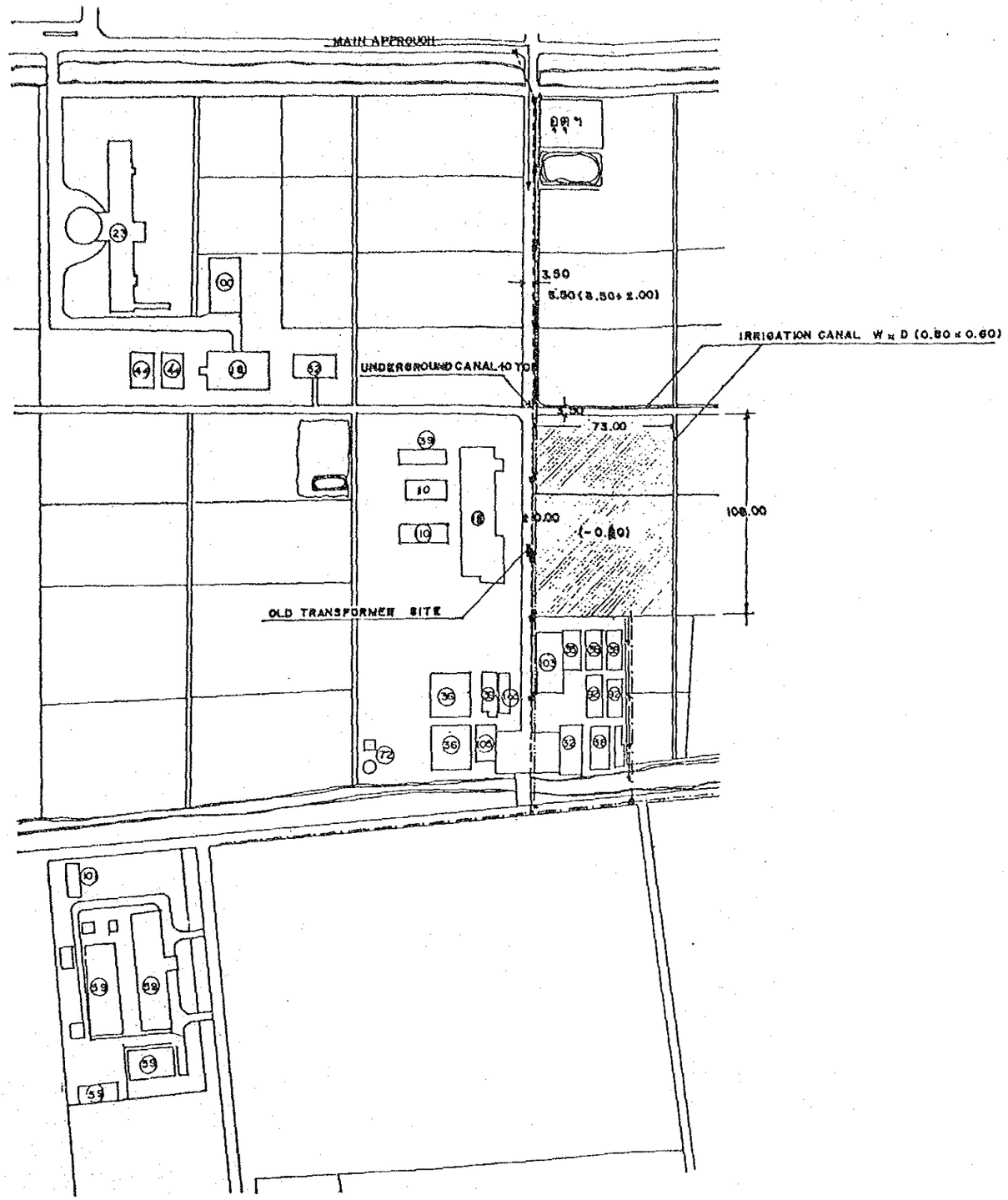
4) Drainage:

At present, there is no sewerage near the planned construction site.

The irrigation canal is installed on the north side of the site. As it is the water route for the field, it is not suitable for drainage. There is a natural drain groove at the back of the warehouse on the east side. It is connected to the drainage canal surrounding the whole field.

5) Approach:

Although the site can be reached from the east side of the front road, it is presently unapproachable for traffic due to a difference in the level at the bridge of the drainage canal caused by ground subsidence. At present, the only road that is secure comes only from the east side. As this road is directly connected to the main road between the premises of the Department of Agriculture and Kasetsart University and there is no special obstacle to the traffic going to NWSRI, there will be no problems in approaching the site.



(18) CONFERENCE BUILDING
(19) WEED SCIENCE BUILDING
(23) INSTITUTE OF RICE RESEARCH
(32) WORKSHOP
(35) POISON STORAGE HOUSE
(36) BIRD PROTECTING HOUSE
(38) CHEMICAL STORAGE HOUSE
(39) GLASS HOUSE
(44) DARK ROOM
(59) RHIZOMBIUM BUILDING
(72) PUMP HOUSE AND PRESSURE TANK
(92) STORAGE
(100) CAR PARK
(101) —
(103) WARE HOUSE
(105) WARE HOUSE
(110) NURSERY

LEGEND :-

POWER LINE 11 KV
POWER LINE 220 VOLT (FOR EXTERIOR LIGHTING ONLY)
MAIN WATER LINE (ϕ6")
CONNECTION POINT WATER
DRAINAGE CANAL W x D (0.80 x 0.60)
OLD TRANSFORMER SITE (150 KVA)