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Study Paper Number 16

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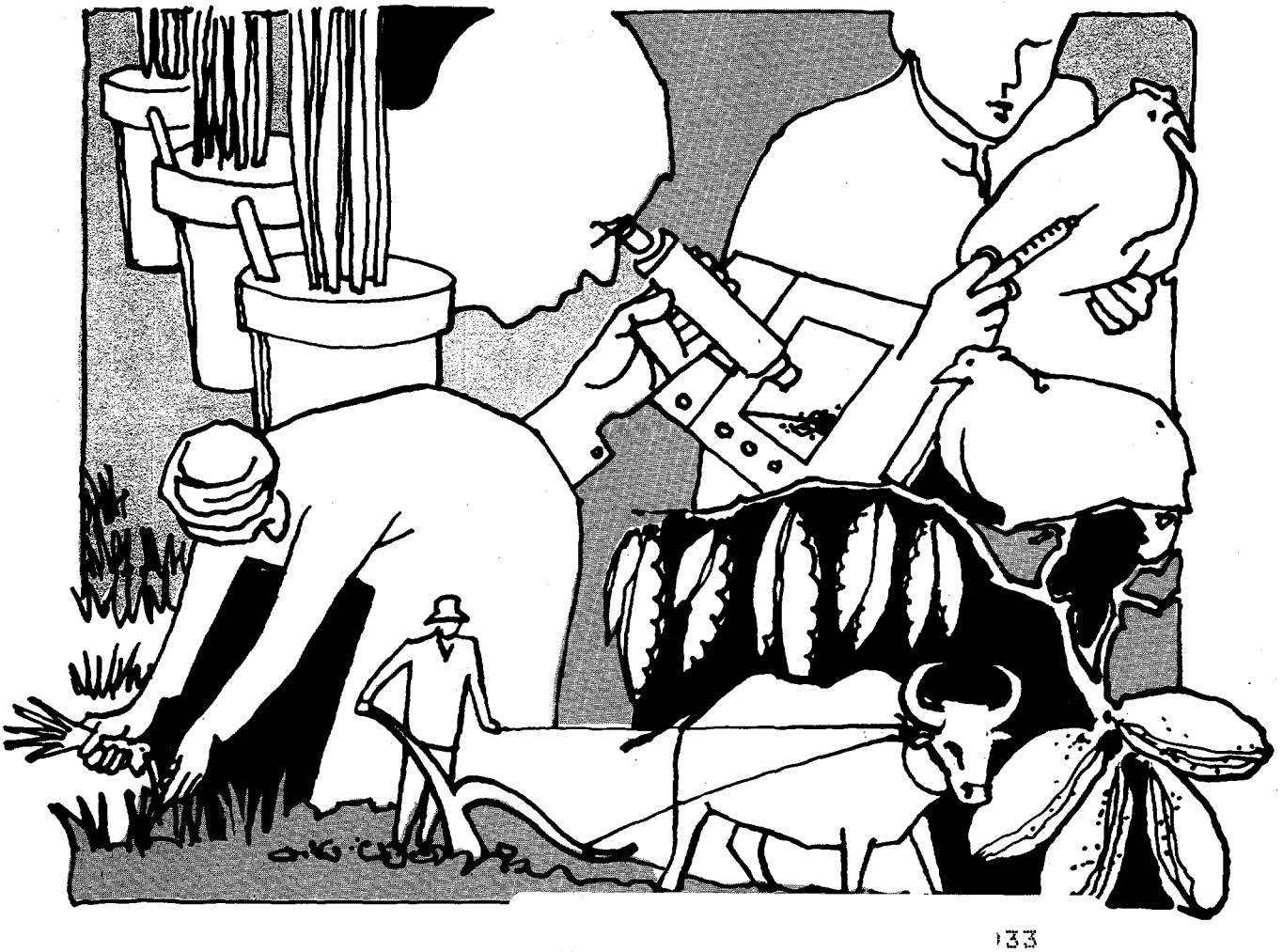
Thailand and the CGIAR Centers

A Study of Their Collaboration in Agricultural Research

Rungruang Isarangkura

CGR 16



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Rungruang Isarangkura

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At its annual meeting in November 1983 the Consultative Group on International Agricultural Research (CGIAR) commissioned a wide-ranging impact study of the results of the activities of the international agricultural research oganizations under its sponsorship. An Advisory Committee was appointed to oversee the study and to present the principal findings at the annual meeetings of the CGIAR in October 1985. The impact study director was given responsibility for preparing the main report and commissioning a series of papers on particular research issues and on the work of the centers in selected countries. This paper is one of that series.

The judgments expressed herein are those of the author(s). They do not necessarily reflect the views of the World Bank, of affiliated organizations, including the CGIAR Secretariat, of the international agricultural research centers supported by the CGIAR, of the donors to the CGIAR, or of any individual acting on their behalf. Staff of many national and international organizations provided valued information, but neither they nor their institutions are responsible for the views expressed in this paper. Neither are the views necessarily consistent with those expressed in the main and summary reports, and they should not be attributed to the Advisory Committee or the study director.

This paper has been prepared and published informally in order to share the information with the least possible delay.

Rungruang Isarangkura is director of the Agricultural Planning Sector of the National Economic and Social Development Board of Thailand.

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Summary

Since collaborative research between Thailand and the CGIAR system was initiated in the early 1960s, many benefits have been derived at both the national and the farm level. Benefits to the National Agricultural Research System have been brought about by organizational changes, enhancement of researchers' capability, provision of genetic materials, and improvements in the methodology of research. All these have resulted in the speedier transfer of benefits to the farm level. It is estimated that the development of rice and corn varieties has benefited at least 30 percent of all farm families. Research administrators and principal scientists have indicated high regard for this collaborative effort.

Contents

Abbreviations and Acronyms

ACIAR	Australian Centre for International Agricultural Research
ADAB	Australian Development Assistance Bureau
ADC	Agricultural Development Council
ASPAC	Asian and Pacific Council
BNF	British Nutrition Foundation
CSIRO	Commonwealth Scientific and Industrial Research Organization (Australia)
DOAE	Department of Agricultural Extension
DPO	Dairy Promotion Organization
DTEC	Department of Technical and Economic Cooperation
FAO	Food and Agriculture Organization
IADS	International Agricultural Development Service (New York)
IDRC	International Development Research Center (Canada)
JICA	Japan International Co-Operation Agency
MOAC	Ministry of Agriculture and Cooperatives
MOF	Marketing Organization of Farmers
MUCIA	Midwest Universities Consortium for International Activities
NESDB	National Economic and Social Development Board
NIFTAL	Nitrogen Fixation by Tropical Agricultural Legumes
NRC	National Research Council
SEARCA	South-East Asia Regional Centre for Graduate Study and Research in Agriculture

CGIAR-supported centers

CIAT	Centro Internacional de Agricultura Tropical
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo
CIP	Centro Internacional de la Papa
IBPGR	International Board for Plant Genetic Resources

ICARDA	International Center for Agricultural Research in the Dry Areas
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
ILCA	International Livestock Center for Africa
ILRAD	International Laboratory for Research on Animal Diseases
IRRI	International Rice Research Institute
ISNAR	International Service for National Agricultural Research
WARDA	West Africa Rice Development Association

1 Agricultural Sector

1.1 Description

Agriculture's share of GDP has declined from 40 percent in 1960 to 28 percent in 1970, 26 percent in 1980 and 22 percent in 1983. Agriculture's contribution to exports has also shown a declining trend from 91 percent of total export value in 1960 to 70 percent in 1970, 58 percent in 1980 and 43 percent in 1983. Agriculture accounted for 82 percent of the total labor force in 1960, but declined to 79 percent in 1970, 72 percent in 1980 and 68 percent in 1983.

The agricultural sector in Thailand is one of the most dynamic in the world. During 1960-75, its growth averaged above 5 percent per annum (Table 1.1). However, between 1975 and 1983 a definite slowing down was apparent. During 1981-83, the sector had an average growth rate of only 2.3 percent per annum. Particularly significant were the slower growth of the forestry and fisheries sectors.

Table 1.1 Annual Growth Rate as Percent of Agricultural GDP at Constant Prices

	1960-70	1970-75	1975-80	1980-83
Crops	4.7	5.2	3.3	2.8
Livestock	3.5	7.6	5.5	3.3
Fisheries	20.7	4.7	-3.1	1.3
Forestry	4.1	2.9	0.3	-7.7

Source: National Economic and Social Development Board (NESDB).

Table 1.2 Crop Subsectors as Percent of Agricultural GDP

	1960	1970	1980	1983
Crops	74	70	73	76
Livestock	14	11	13	13
Fisheries	3	12	9	8
Forestry	9	7	5	3

Source: NESDB.

The crop subsector has been the most important, contributing between 70 and 76 percent of agricultural GDP during 1960-83 (Table 1.2).

Cattle and buffalo have contributed about 20 percent of livestock GDP since 1980. Their relative importance in the sector has been declining due to the faster increase in poultry production.

The relative shares of various crops in crop GDP during 1960-83 are presented in Table 1.3. Rice has been the most important crop, even though its relative importance has been declining since 1960. Fruit crops are second in importance.

The area under cultivation for various crops is shown in Table 1.4. The averages over the period from 1977/78 to the 1981/82 crop years show that rice was grown on about 60 percent of the total crop area, with an increasing trend averaging 2.4 percent annually. However, most other crops show a much greater rate of area expansion.

Production volumes of various crops averaged over 1977-84 are presented in Table 1.5. By volume of production, paddy, cassava and sugarcane were outstanding. The average rates of

Table 1.3 Relative Contributions of Various Crops to Crop GDP at Current Prices

Crop	1960	1970	1980	1983
		(in percent)		
Rice	44	35	35	33
Corn/Sorghum	2	6	6	5
Sugarcane	2	3	9	9
Cassava	2	3	8	7
Rubber	11	7	6	7
Fruit Crops	16	18	17	16
Vegetables	5	12	7	12
Tobacco	4	3	4	3
Beans	4	3	3	3
Coconut	2	2	1	1
Cotton	1	1	1	1
Kenaf	3	3	1	1
Others	4	4	2	2

Source: NESDB.

increase in production were rather impressive in all crops except coconut, which experienced a decline due to the existence of many old coconut trees.

Agricultural exports during 1960-82 are shown in Table 1.6. In 1960, rice and rubber accounted for 66 percent of the total, but decreased to only 30 percent in 1982. Other products such as cassava, corn, sugar, shrimps, tobacco, beans and canned pineapples, have become more important lately.

Table 1.4 Cultivation Areas by Crops

Crop	Average 1977/78 to 1981/82		1982/83	1983/84
	Million Rai*	% Increase	Million Rai	
Paddy	59.6	2.4	60.1	62.1
Corn	8.9	4.4	10.5	10.6
Cassava	7.1	10.8	8.6	9.2
Sugarcane	3.3	5.6	3.7	3.6
Mungbeans	2.8	21.4	3.1	3.1
Sorghum	1.3	14.8	1.5	1.7
Soybeans	0.9	8.1	0.8	1.0
Groundnuts	0.7	0.7	0.8	0.8
Cotton	0.7	65.5	0.7	0.6
Kenaf	1.5	7.4	1.4	1.3
Tobacco	0.3	3.7	0.3	0.2
Rubber	9.6	1.6	10.0	10.1
Coconut	2.4	-0.5	2.4	1.8
Others	0.5	-	0.7	0.2

Source: Ministry of Agriculture and Cooperatives.
Note: *6.25 Rai = one hectare.

1.2 Problems

Farmers' incomes have recently declined due to over-production of traditional commodities, higher costs of production, and relatively low quality of farm products.

The growth rate of the agricultural sector has dropped because of an end to the land frontier. Consequently, crop planted area has increased on an average of only 1.5 percent per annum in the past few years, compared to a rate of 3.5 percent per annum during 1975-81. Productivity improvement has only

Table 1.5 Total Crop Production by Commodities

Crops	Average 1977/78 to 1981/82		1982/83	1983/84
	Million Tons	% increase	Million Tons	
Paddy	16.5	4.1	16.9	18.7
Corn	2.8	10.3	3.0	3.6
Cassava	15.9	12.5	18.9	21.0
Sugarcane	10.5	10.1	24.4	21.6
Mungbeans	0.25	20.1	0.28	0.30
Sorghum	0.21	16.5	0.24	0.33
Soybeans	0.12	8.6	0.11	0.18
Groundnuts	0.12	1.6	0.15	0.15
Cotton	0.14	67.5	0.21	0.12
Kenaf	0.24	4.5	0.20	0.23
Tobacco	0.04	5.6	0.05	0.04
Rubber	0.48	5.3	0.58	0.59
Coconut	0.56	-8.3	0.26	0.11

Source: Ministry of Agriculture and Cooperatives.

contributed to growth in irrigated areas, which account for only 16 percent of the total agricultural land.

Seasonal unemployment has become more critical, since transfer of agricultural technology to increase dry season agriculture has not been effective.

Based on the assessment of the World Bank Commodities Division, except for kenaf, sugar and possibly rice, Thailand's main agricultural products face relatively favorable export demand. For cassava, restrictions of Thai exports to the EEC are a main constraint. Although demand is not expected to be the limiting constraint to Thailand's agricultural products, future

Table 1.6 Percentage Composition of Agricultural Products in Total Agricultural Export at Current Prices

Crops	1960	1970	1980	1982
Rice	40	24	24	21
Rubber	26	21	15	9
Cassava	5	11	18	18
Corn	6	18	9	8
Sugar	2	1	4	13
Shrimp	-	2	4	3
Tobacco	-	-	2	2
Mungbeans	-	2	2	2
Canned Pineapples	-	-	2	2
Others	21	19	20	22

Source: NESDB.

exports will probably face stiffer competition and more protectionism in the world market than in the past.

1.3 Government agricultural policy

Agricultural growth in Thailand has been due mainly to the efforts of the dynamic private sector, both in the farming and trading communities, which have enabled favorable world market opportunities to be quickly reflected at the farm level. In addition to finding export markets, the private sector has provided key services such as transportation, grading, storage, tractor ploughing, input supply and financing.

The government has contributed to growth in agriculture mainly by providing infrastructure, particularly in road and irrigation facilities, and by its role in crop breeding. In

recent years, government has been allocating about 60 percent of its total expenditure in agriculture to irrigation systems. Agricultural development objectives have been concentrating on poverty eradication and farm income improvement, through efficient use of land, water and labor, to increase return per unit area and to reduce costs of production per unit weight of output. However, in recent years, the government has attempted to regulate the supply of some commodities facing a demand constraint, such as cassava and sugarcane, by declaring agroeconomic zones for some crops, to which production is supposed to be confined. However, due to the lack of enforcing measures, this zoning concept has not been effective.

Thailand has adopted an essentially free-trade policy. The government has intervened very little in agricultural marketing except for rice, in which export taxes are collected, and cassava, in which export quotas are regulated to minimize difficulties with EEC. Overall, the government has indicated its intention to liberalize markets, facilitate exports and ensure that farmers have adequate access to market information. It has shown its unwillingness to intervene in direct purchasing of farm produce except where markets are uncompetitive.

1.4 Agricultural prices and wages

Farmgate prices of 14 commodities from 1960 through 1984 are presented in Table 1.7, with their 5-year averages shown in Table 1.8. Prices of all the commodities tended to increase during the period, but the increase was slow from 1960 to 1972. The sharp increase from 1972 to 1979 resulted largely from the global commodity boom of 1973-74, which caused significant price increases for all Thai agriculture, particulary rice, cassava and sugarcane. From 1980 to 1984 prices experienced another period of slow growth, corresponding to the weak global economic situation. Therefore, there is a clear and close linkage between farm prices of Thai agricultural commodities and the world market situation.

Table 1.7 Farmgate Prices of Agricultural Commodities from 1960-1984 (Baht/kg)

Crops	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Rice, Nonglutinous	0.85	0.91	1.00	1.03	0.88	0.91	1.27	1.15	1.13	1.07	0.93	0.74	0.98
Rice, Glutinous	--	--	0.75	0.74	0.71	0.86	1.18	1.07	1.03	0.90	0.67	0.52	0.82
Corn	1.01	1.12	0.78	0.84	0.82	0.84	0.87	0.82	0.72	0.80	0.81	0.75	0.84
Sorghum	--	--	--	--	--	--	--	0.89	0.86	0.86	0.83	0.87	0.78
Mungbeans	1.72	2.32	2.56	1.90	1.97	1.66	2.28	2.65	2.41	2.16	2.17	2.59	3.02
Soybeans	1.89	2.43	2.26	2.03	2.01	2.46	2.32	2.04	2.17	2.14	1.94	2.60	3.26
Groundnut	--	--	1.54	1.74	2.02	2.01	2.19	2.44	2.36	2.42	2.24	2.13	2.49
Cassava	0.63	0.65	0.49	0.31	0.28	0.29	0.33	0.32	0.33	0.45	0.39	0.54	0.46
Sugarcane (Baht/ton)	108.40	110.10	93.52	93.82	120.13	95.26	105.85	105.74	103.59	108.68	118.10	122.00	141.48
Cotton	3.76	3.60	3.02	3.07	3.06	3.97	3.03	3.39	3.79	3.20	3.24	3.55	4.45
Kenaf	3.17	2.33	2.20	2.22	2.31	2.32	2.82	2.82	1.56	0.94	2.20	2.27	3.11
Castor Beans	2.60	2.04	2.02	1.90	2.13	1.83	1.77	1.68	2.11	1.88	1.73	1.62	2.48
Tobacco	13.33	13.73	11.04	13.20	8.93	8.85	9.74	7.54	11.00	8.83	8.38	11.00	14.39
Rubber	9.60	8.47	7.70	6.78	6.51	6.84	6.23	5.03	5.41	7.00	6.26	6.00	5.03

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Rice, Nonglutinous	1.56	2.15	2.21	2.01	2.05	2.40	2.50	2.99	3.43	2.87	3.23	3.15
Rice, Glutinous	1.39	1.87	2.10	1.92	1.87	1.78	2.19	2.48	2.89	2.71	3.27	2.37
Corn	1.26	1.95	1.86	1.66	1.60	1.63	2.04	2.40	2.23	2.25	2.37	2.76
Sorghum	1.14	1.78	1.50	1.37	1.42	1.51	1.93	2.28	2.65	2.10	2.54	2.76
Mungbeans	3.41	4.42	3.78	4.92	5.67	6.41	5.52	7.02	8.30	8.17	8.71	8.15
Soybeans	4.15	4.57	4.36	5.10	6.27	5.56	5.67	6.58	6.68	6.30	6.80	7.08
Groundnut	2.98	3.62	3.74	4.29	4.59	5.11	5.44	7.57	6.65	6.27	8.66	5.84
Cassava	0.32	0.31	0.40	0.46	0.48	0.36	0.74	0.75	0.54	0.54	0.77	0.61
Sugarcane (Baht/ton)	141.39	195.10	255.08	285.70	283.12	280.95	295.63	406.00	613.00	399.00	316.69	346.60
Cotton	5.46	6.75	6.39	6.07	7.57	8.12	10.25	10.50	11.48	9.77	11.96	12.27
Kenaf	2.97	2.47	1.73	2.09	2.79	2.68	2.67	3.26	3.57	4.01	3.69	3.66
Castor Beans	3.33	4.75	3.06	3.74	4.75	5.05	5.33	5.80	5.75	5.20	4.97	6.48
Tobacco	17.49	25.28	25.95	29.55	33.82	29.05	36.38	44.79	36.20	38.40	48.89	44.50
Rubber	8.72	8.52	7.60	10.17	10.97	12.99	16.20	17.50	14.49	13.12	16.73	15.96

Note: Prices for 1984 are estimated based on actual prices of January to July.
Source: Office of Agricultural Economics, Ministry of Agriculture and Cooperatives.

Table 1.8 Farmgate Prices of Agricultural Commodities by Five-Year Average during 1960-84

Crops	Averages (Baht/kg) 1960/64	1965/69	1970/74	1975/79	1980/84
First Grade Non-Glutinous Rice	0.94	1.12	1.27	2.23	3.14
Glutinous Rice	0.73	1.01	1.05	1.97	2.74
Corn	0.91	0.81	1.12	1.76	2.40
Sorghum	-	0.87	1.08	1.55	2.47
Mungbean, First Grade	2.09	2.23	3.12	5.26	8.07
Soybean	2.12	2.23	3.30	5.39	6.69
Groundnut, Unshelled	1.77	2.28	2.69	4.63	6.99
Cassava	0.47	0.34	0.40	0.49	0.64
Sugarcane (Baht/ton)	105.19	103.82	143.61	280.10	416.26
Cotton, Seeded	3.30	3.48	4.67	7.68	11.20
Kenaf, Mixed Grade	2.45	2.09	2.60	2.39	3.64
Castor Beans	2.14	1.85	2.78	4.39	5.64
Tobacco, Virginia	12.04	9.19	15.31	30.95	42.56
Rubber, First Grade Sheet	7.81	6.10	6.91	11.59	15.56

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

Thailand has one of the lowest levels of fertilizer use in Asia in terms of average consumption per unit of cultivated area. Current crop yield levels are low in relation to yield levels recorded in neighboring countries.

However, the rate of application in irrigated areas is quite comparable with that in other countries and, consequently, the yield of paddy in irrigated areas is usually above 3 t/ha.

Table 1.9 Fertilizer Use and Rice Yields for Selected Countries

Country	Nitrogen/Paddy Price Ratios	Fertilizer Use N kg/ha (1978)	Yield ton/ha (1970)
Japan	0.44	449.6	6.2
Korea	0.74	391.9	6.6
Bangladesh	1.62	41.4	1.9
Sri Lanka	1.73	62.5	2.0
Burma	1.97	8.5	2.0
Indonesia	1.07	44.9	3.0
Malaysia	2.46	57.1	2.9
Philippines	3.10	38.5	2.0
India	3.34	26.7	1.8
Pakistan	3.85	44.1	2.5
Thailand	3.89	16.5	1.9

Source: World Bank.

Annual fertilizer use is about 800,000 tons. About 60 percent of all fertilizer is applied to rice, explaining the importance of NP compound fertilizer (16-20-0), which is the commonly used fertilizer for rice. Therefore, the price of rice fertilizer can be used to represent the price of all chemical fertilizers. Reliable farmgate prices of paddy fertilizer during the period 1960-68 are not available, but those for 1969-84 are presented in Table 1.10.

Wages actually received by farm labor are not well documented, particularly for 1960-69. Table 1.11 provides a set of data used in the input/output analysis of NESDB in Baht worker-day units.

Table 1.10 Farmgate Prices of 16-20-0 Compound Fertilizer

	Year	Baht/kg
	1969	2.30
	1970	2.38
	1971	2.25
	1972	2.42
	1973	2.55
	1974	4.73
	1975	4.26
	1976	3.20
	1977	2.43
	1978	2.72
	1979	3.38
	1980	5.73
	1981	6.00
	1982	4.71
	1983	4.47
	1984	4.20
Average:	1965-69	2.30
	1970-74	2.47
	1975-79	3.20
	1980-84	5.20

Source: Ministry of Agriculture and Cooperatives.

Table 1.11 Wage of Farm Labor

Year	Baht/worker-day
1970	18
1971	19
1972	20
1973	23
1974	28
5-Year Average	21.6
1975	30
1976	33
1977	38
1978	39
1979	46
5-Year Average	37.2
1980	54
1981	54
1982	54
1983	55
1984	56
5-Year Average	54.6

2 Evolution of the National Agricultural Research System

2.1 History of the agricultural research system

2.1.1 Establishment of research institutions

This section is drawn mainly from a book published by the Ministry of Agriculture and Cooperatives (MOAC) in April 1981 (in Thai) to celebrate its 89th anniversary.

Agricultural research in Thailand began in B.E. 2446 (1903) when a prince who graduated in agriculture abroad returned home to set up education programs in farming, acquired a piece of land in Nakorn Pathom, about 60 km northwest of Bangkok, started a livestock breeding program, and also started sending students to further their education overseas. In 1908, the Department of Farming was established in the Ministry of Agriculture, and made responsible for crop production.

In 1915, the first experimental station was set up in Phrom Piram district in the northern Phitsanulok province, to conduct research focusing on cotton improvement. Some attention was given to rice and tobacco. The Ministry of Agriculture hired American experts to assist in the cotton improvement program.

In 1916, experimental farms for fruit crops and rice were established in Thonburi and in Rangsit, Bangkok, respectively. Reorganization of the Ministry of Agriculture in 1938 resulted in separation of activities for crops, livestock and fisheries into three separate departments.

In 1953, paddy improvement was given even greater support by the upgrading of the rice unit from a division in the Department of Agriculture to a separate rice department.

In 1968, crop promotion activities were removed from various departments in the Ministry of Agriculture, and the Department of

Agricultural Extension (DOAE) was set up and made responsible for crop extension thus separating research from extension. Similarly, in 1971, the Dairy Promotion Organization (DPO) was established as a state enterprise responsible for dairy promotion. The Department of Livestock was more or less left with research activities. Setting up of the DPO was assisted by the Danish government.

Another reorganization of the Ministry of Agriculture, in 1972, combined the Departments of Agriculture and Rice into a single crop research institute under the name of the Department of Agriculture. Thus from 1972 to present, research on crops in the Ministry of Agriculture (which later changed its name to the Ministry of Agriculture and Cooperatives) has been in the Department of Agriculture, while crop extension has been the responsibility of the DOAE.

Economic analysis of agricultural activities within the Ministry of Agriculture has recently received more support through upgrading the Agricultural Economics Division in the Office of Permanent Secretary of the Ministry to departmental status in 1979.

Next in importance to the MOAC with regard to agricultural research activities are the universities. Kasetsart University in the central region was set up in 1942, Chiang Mai University in the north in 1964, Khon Kaen University in the northeast in 1965, the Prince of Songkla University in the south in 1967, and Mae Joe Institute of Agricultural Technology in the north was reorganized and upgraded from an agricultural college to university level in 1975.

2.1.2 Development of some commodity research programs

<u>Rice</u>

The rice improvement program in Thailand was initiated around 1910 with a Rice Contest Fair to induce farmers' awareness

of the need to make varietal selection. The varieties selected at the fair were tested by the Department of Farming and seeds were multiplied and subsequently distributed to farmers. The first rice experiment station was set up in 1916 in Rangsit as the first step towards organized rice research activities in the kingdom. The station produced a well-known rice variety, Pin Kaew, which won first prize in the World Grain Exhibition Conference in Canada in 1933. After World War II, Thailand became a member of FAO, and through that organization, the USA sent Dr. H. H. Love to assist the research program in 1950. In the same year, through FAO, the International Rice Commission set up the Indica-Japonica Hybridization program from which Thailand also benefited. After the establishment of IRRI in the Philippines, the Rockefeller Foundation sent a rice breeder (Ben Jackson) to Thailand in 1966, who brought with him a large collection of IRRI rice genetic materials. Since then, at least 15 high-yielding non-photosensitive varieties have been released, which virtually dominate irrigated rice in Thailand. They are known by the names of R.D. numbers 1 through 9, 11, 13, 15, 17, 19 and 23.

Rice research in Thailand in the early phase was aimed at varietal selection for higher yield. Later, attention focused on overcoming lodging, since most rice growing areas were deep flood lands. The new plant types from IRRI with short, stiff straw were crossed with taller Thai varieties. In the 1960s, when Suben Tungro virus disease was widespread, rice breeders paid much attention to finding varieties resistant to the disease. By the late 1960s, R.D. 1 to 3 were released which resulted from crosses between local varieties and IRRI materials. By the mid-1970s, other R.D. lines followed, most of them semi-dwarfs. By the early 1980s, the series had reached R.D. 21 and 23. All along, plant breeders were aware of the need for deep-water tolerance and for a suitable eating quality variety, which would permit improvement of rice production in most growing conditions

of the kingdom. In 1979, R.D. 19, a variety tolerant of water depth of up to one meter, was released. This variety is still the recommended variety for the central region. Rice research now concentrates on early maturation, plant height, shape and size of grain, and resistance to Blast, Bacterial Leaf Blight, Tungro Virus, Brown Spot, Gall Midge, and Brown Plant Hopper, under various agroecological conditions.

Wheat

A group of scientists, working in the north, attempted to promote wheat production in the area for import substitution. Plants and materials were brought in from Australia and India in 1933, and trials were conducted at Phrae Agricultural College in the region. During the period 1942-1963, more plant materials were imported from several sources, including Japan, Burma, USA, Taiwan, India and also through FAO, but the results were not very fruitful. Organized wheat research actually began in 1963 with the introduction of plant materials from CIMMYT. During 1967-69, more plant materials were introduced from CIMMYT, resulting in the release of an early variety, Fang 589 or Sonora 64. Samoeng Experiment Station was established in 1979 to conduct research in upland rice and temperate grain crops, including wheat. In 1980, CIMMYT assisted the Department of Agriculture by sending a plant breeder (Eugene E. Saari) and an agricultural economist (Roger Montgomery) to Thailand. Subsequently, wheat research has been expanded in three experiment stations in the north, Fang Chiang Rai and Samoeng. The recommended varieties are Inia 66 and Sonora 64, both originated from CIMMYT parent materials. However, the real production trend is the reverse of the research effort. The maximum wheat area was about 911 ha in 1967 with a production of 300 tons. In 1983, the total crop area was only 150 ha, with 150 tons of wheat production. The reason for the decline in production, given by the DOAE, was that farmers were not familiar with the crop and considered it too difficult to grow. Therefore, wheat remains a minor crop in the kingdom.

Barley

Barley is another little-known crop and the interest has been mainly among researchers working in the northern part of Thailand, where climate conditions are more suitable for temperate crops. Introduced plant materials from CIMMYT formed the basis of all research work (Department of Agriculture, 1983). Consequently, two varieties, Samoeng 1 and 2, were released in 1974. The crop had little demand until 1984, when a local company showed interest in buying it (MOAC, 1984).

Cassava

Although tapioca was used in bread-making in Malaysia, that country enacted a law prohibiting rubber growers from growing two crops of cassava interrowed with rubber trees. This act forced cassava planters to move across the border from Malaysia to the southern part of Thailand. Research on cassava in Thailand started in 1937 at Kho Hong Experimental Station in the south, which concentrated mainly on rubber research. After World War II, there was a great demand for tapioca flour in Japan and the US, and cassava production in Thailand moved from the south to the eastern part of the central region. Real research work on cassava then started at Huey Pong Upland Crops Experimental Station in Rayong province in the eastern part of the central plain. In Thailand, nearly 99 percent of the cassava acreage is planted with a traditional cultivar Rayong 1, which is highly productive. The Huey Pong Station introduced hybrid seed from CIAT in 1975 for breeding purposes, and released Rayong 3 in 1983 with high starch content and Rayong 2 for table use (Department of Agriculture, 1983).

Many local X CIAT selections are showing highly promising results, particularly with regard to "toughness" and "earliness" in farmers' fields. The majority of Thai X CIAT crosses show better resistance to cassava bacterial blight than Rayong 1 (Kawano, 1984). The disease is widespread and can cause significant yield damage.

Mungbean

Research work on mungbeans began in 1937 at Uu Thong Experimental Station. The station released two varieties, Uu Thong 1 and 2, which have been used for extension work all along. The origin and the parent materials of these varieties cannot be confirmed.

Soybean

Research on soybeans began in 1970 with the collection of 1,700 varieties from various countries for selection. In the same year, with the assistance of the Japanese government, a soybean breeding program was initiated. Up to now the S.J. series has been established and S.J. 1 to 5 have been released by Mae Joe Experimental Station (Kazuo Kawano et al., 1984).

Corn

Research on corn in an organized manner began in 1959 with the assistance of an expert from the Rockefeller Foundation. Through the program, plant materials from Guatemala were supplied to researchers in Thailand, from which an improved corn variety, Phra Putabaht 3, was released in 1969. In the same year, the National Corn and Sorghum Research Center was established, jointly managed by Kasetsart University and the Department of Agriculture, with the assistance of the Rockefeller Foundation. The Center has performed excellent research work which is recognized worldwide. Up to now, four varieties have been released and have been well accepted by corn growers. Phra Putabaht 5, originated in Guatemala, produces good yield but is susceptible to downy mildew disease. Pak Chong 1602 is similar to Pra Putabaht 5. A mildew-resistant variety was selected from parent materials from Indonesia, the Philippines and Taiwan and released as 6. In 1975, Suwan 1, a mildew-resistant variety, was released and has been popular ever since. The recently released hybrid 2301 is characterized by drought resistance. This brief history of corn research was constructed from interviews with the Dean of Agriculture Faculty, Kasetsart University

and the Director of the Upland Crops Institute in the Department of Agriculture.

Obviously, the Rockefeller Foundation has played a crucial role in corn research in Thailand. Even though CIMMYT has been officially in Thailand only since 1980, its contribution to research can be traced back long before that. Thai researchers were trained at CIMMYT in Mexico and the currently recommended corn varieties also originated from CIMMYT germplasm.

Livestock

About 800 head of American Brahman were imported in 1954 for breed improvement. In the same year, a dairy herd improvement program was launched and Brown Swiss parent stocks were introduced with USAID assistance. In 1961, the Danish government provided Red Dane stocks, and in 1966 the Republic of Germany gave German Brown for dairy herd improvement purposes. It is obvious that, in the early phase, livestock research and development concentrated on breed improvement. As a result, beef cattle with 50 to 75 percent of American Brahman in a cross with the local breed are recommended, leading to about 40 percent greater weight than the local breed. For the dairy herd, Holstein Frisian have been found to be suitable for Thailand (MOAC, 1981).

2.2 The present national agricultural research system

2.2.1 Research institutions

Agricultural research in Thailand is conducted by both public and private institutions, but little is known about agricultural research activities carried out by the private sector. However, because of the limited number of firms investing in agricultural production in the country, it can be assumed that the role of the private sector is minimal in comparison with the services provided by the public sector.

Agricultural research is carried out by several government agencies as shown below. There are eight main ministries involved in agricultural research, of which the Ministry of Agriculture and Cooperatives and the Bureau of Universities are the two most important. The Ministry of Interior is involved in highland agriculture for improvement of hill tribes' welfare. Its main research activity has been on highland agriculture and agricultural economics. Agricultural colleges under the Minister of Education carry out simple farm testing for teaching purposes, and so far have not contributed significantly to advancement in agricultural technology. Sugarcane research programs have been undertaken by the Ministries of Industry and Agriculture and Cooperatives and the Bureau of Universities, but sugar policies are determined by the Ministry of Industry. Tobacco research programs have been conducted mainly by the Tobacco Monopoly under the Ministry of Finance. However, because of cash flow problems, the Tobacco Monopoly has reduced its research programs and budget to a minimum. This reduction in research investment in the Tobacco Monopoly was not compensated by an increase in the tobacco research budget of MOAC. Consequently, research activity in tobacco has been stagnant lately. The role of the Applied Scientific Research Corporation of Thailand has been mainly on agro-processing improvement, but its contributions have been limited by relatively small funding. The Ministry of Commerce has been producing reports on commodities at irregular intervals, aiming at identification of production and marketing problems.

Institutions conducting agricultural research in Thailand are:

Ministry of Agriculture and Cooperatives

- Department of Agriculture (85 experiment stations)
- Office of Permanent Secretary (4 regional offices)
- Office of Agricultural Economics
- Land Development Department (40 land development centers)
- Department of Forestry

Department of Livestock
Department of Fisheries
Ministry of Interior
Public Welfare Department (Tribal Welfare Research Center)
Bureau of Universities
Kasetsart University (Central Region)
Chulalongkorn University (Central Region)
Khon Kaen University (Northeast)
Mae Joe Institute of Agricultural Technology (North)
Ministry of Education
Agricultural Colleges
Ministry of Industry
Sugarcane and Sugar Institute
Ministry of Finance
Tobacco Monopoly
Ministry of Science, Technology and Energy
Applied Scientific Research Corporation of Thailand
Ministry of Commerce
Department of Commercial Economics

2.2.2 Coordination of research activities and linkages with extension

It is obvious that there are many research institutes in Thailand, but less obvious is the mechanism for coordination of the research programs of these numerous institutes. The important points are that: (1) the agricultural research effort in Thailand has occurred at the departmental rather than at the national level; (2) the effectiveness of investment policy on agricultural research is questionable; (3) technology development is institutionally isolated from technology diffusion, and (4) research activities have been conducted in isolation from economic analysis of marketing conditions and input availabilities.

There has never been a national agricultural research plan in Thailand. A technology and science development plan exists, but it is too broad to guide agricultural research activities in the various institutions. Research programs have been conceived by scientists in the research institutes based on their functional responsibilities and their own interests more than on the national needs. Top managers of the research institutes are more occupied with day-to-day operations than with developing longer-term perspectives for agricultural research. Therefore, decision making cannot really be judged against appropriate priorities. Without a long-term outlook, effective coordination of research activities cannot be expected.

Several attempts have been made to coordinate research activities. Many working groups on specific commodities exist at working levels. At the national level, in the last 4 years the government has established the Agricultural Research Council aimed at agricultural research coordination. So far, the council has not held a meeting.

Crop extension activities are in the DOAE. Formal linkages between extension and research are expected through the National Agricultural Extension Project Coordinating Committee and the National Agricultural Research Project Coordinating Committee. Under the National Extension Project, working groups at the provincial level have been established. According to the records, none of the committees have met more than twice a year, which does not indicate a very effective system. In addition, since the coordinating mechanisms are on a project basis, very likely they would end with the projects.

Services for the supply of inputs are mainly through the Marketing Organization for Farmers (MOF), which is a state enterprise within the MOAC. There is no clear linkage between research organizations and agencies concerned with the marketing of farm outputs and inputs.

Research activities on fisheries and livestock are in their respective departments, but it is still being debated whether extension activities for the two subsectors should be kept there or should be transferred to the DOAE, which has extension staff down to the sub-district level, whereas the other two departments operate only at provincial and some district levels.

The World Bank has been playing an active role in improving agricultural research in Thailand. Many foreign experts have produced reports on agricultural research. The 1970 FAO report, No. TA 2849, based on the work of Mr. A. C. Evens, an FAO research organization advisor who spent 11 months in Thailand in 1969, identifies the following weaknesses in agricultural research:

(1) absence of a national agricultural research program;
(2) dispersion of responsibility for agricultural research among many agencies, coupled with the lack of an effective coordinating mechanism;
(3) dearth of opportunity for full-time research careers in research; and
(4) inadequate training in research training techniques and methodology.

In order to overcome these and other weaknesses, the report proposes:

(1) the formation of a National Agricultural Research Council to formulate and review national agricultural research programs, supported by several coordinating committees;
(2) establishment of technical study groups of research workers to maximize cooperation;
(3) strengthening of the Agricultural Research Institute pending the time when all the research agencies can be amalgamated into one department or semi-autonomous organization; and
(4) improving systems and procedures for recruitment,

training, career structure, organization, planning, liaison with extension, central documentation and publication.

Based on a 5-week visit by Mr. Mosoman from the Agricultural Development Council in September/October 1973, a report was submitted to the Thai government identifying the following problems with the Department of Agriculture:

(1) duplication and lack of coordination with other research agencies;
(2) isolation from extension and the practical problems of producers;
(3) internal organizational structure with inherent delay in decision making;
(4) fragmentation of staff into separately functioning units;
(5) lack of economic guidance and expertise in setting and implementing research programs; and
(6) proliferation of uncoordinated foreign technical assistance which often obscures or contradicts national priorities.

The report recommends the following:

(1) reorganization of the Department of Agriculture under a Deputy Director-General responsible for research and two assistant Directors-General for administrative and for technical services, respectively, with appropriate regrouping or merging of divisions;
(2) re-establishment of a national network of experimental stations;
(3) integration of regional agricultural centers with the Department of Agriculture;
(4) association of the research facilities of the universities more closely with the program of the Department of Agriculture;
(5) improvement of the program budgeting procedures;

(6) planning of research projects on a national basis; and other recommendations.

Another report was prepared by a joint MOAC and Midwest Universities Consortium for International Activities team in 1974 in "Serving Agriculture in Thailand" (MUCIA Report). The report recognizes the same weaknesses detailed in the two previous reports and makes the following broad recommendations:

(1) restructuring based on consolidation (i.e., fewer units to produce a critical mass of research workers), decentralization into regional centers, and relevance, in the sense of developing more problem-oriented research priorities;
(2) transferring senior research staff to the regions to staff the field stations;
(3) giving more autonomy to regional research staff;
(4) establishing commodity research programs;
(5) creating an effective staff development and rewards system;
(6) introducing a greater involvement by university staff in planning and evaluation of reseach programs, as well as in the conduct of research, and permitting lateral transfers or joint appointments;
(7) building up a National Agricultural Research System, based on multidisciplinary research performing units, to conduct research programs according to a 5-year rolling program;
(8) creation of a set of regional multipurpose agricultural (research-extension development) centers to carry out adaptive research, subject matter support, and field staff training; and other recommendations.

In 1975, another report on agricultural research and extension in Thailand was produced by the World Bank (National Agricultural Research and Extension Project, Bank Identification

Report, 1975), which deals mainly with the organizational and technical weaknesses of agricultural research, and recommends:

(1) the establishment of a National Agricultural Research Council, linked to the National Research Council (NRC), and serviced by an efficient secretariat;
(2) transfer of sugarcane, tobacco, and forage research to the Department of Agriculture;
(3) conversion of the Department of Agriculture and other related research agencies to an autonomous new organization, which could effectively overcome many of the present weaknesses;
(4) increased collaboration with international research institutes;
(5) introduction of more rigorous scrutiny of research project proposals; and
(6) establishment of a National Bureau of Plant Introduction and an efficient regulatory agricultural service.

The World Bank continues to develop its investment project in agricultural research for Thailand. More reports were produced during 1975-77. In 1978, a National Agricultural Research Project Brief was submitted to various authorities of the Thai Government. By 1980, the full project document was ready for appraisal, and in 1981 the research project was implemented with a total cost of about US $108 million. The objectives of the project are to strengthen the capacity and capability of the Department of Agriculture to implement national agricultural research programs, and to provide relevant technology through the agricultural extension service for farmers. The project would seek to achieve these objectives by providing staff, fellowships, consultants, facilities, equipment, materials and supplies in support of the Department of Agriculture research operations. This has been the only large-scale investment project in agricultural research in the kingdom. In terms of

budget, facilities and personnel, the Department of Agriculture is an agency that is well-equipped to carry on research work. The main problem now is operation to fulfill expectations. So far, performance has not been very satisfactory. Much effort has been spent on procurement and construction, but little on development of the Department's research system and identification of research projects.

The World Bank also assists Thailand in agricultural extension services in the DOAE, which provides extension services for most agricultural crops to the 5 million farm families. The World Bank has introduced the training and visit (T & V) system of extension in DOAE which was intended to cover the whole kingdom by 1984.

2.2.3 Research funding authorization

Requests for agricultural research funds in the government development budget are submitted to the NESDB for review and passed to the Cabinet with recommendations whether to approve or reject them. The majority of research projects have taken this route. Another channel for funding is from the NRC in the Ministry of Science, Technology and Energy. Annually, the Budget Bureau in its budget bill also includes a lump sum for research work to be managed by NRC, which has amounted to about Baht 10 million annually. Individual researchers can also request financial assistance directly from NRC. Another source of funds is external grant assistance, which is principally managed by the Department of Technical and Economic Cooperation (DTEC) in the Prime Minister's Office, whose mandate is to seek external grant assistance and to review the aid component. Government agencies can request DTEC to seek external assistance to implement research projects.

2.3 Investment in agricultural research

2.3.1 Total investment in agricultural research

Total investment in agricultural research from 1975 to 1984 is presented in Table 2.1. The data are obtained from the annual government budget published by the Budget Bureau. They might have been somewhat overestimated since they were for commitments rather than actual expenditures. They include wages and salaries of all researchers, some of whom might have been working on non-research activities and they do not account for transferal of funds to non-research activities, which is a common practice towards the end of the fiscal year. Differences from data in other studies occur, which can be explained, in addition to the shortfalls mentioned above, by different classifications of agricultural research activities. For example, the NRC published a paper on "Studies and Analysis of Research Budget Allocated to Government Agencies and Public Enterprises" for budget years 1978, 1979 and 1980. In the article, the research budget included just about all activities in the MOAC, including irrigation development. Since irrigation system construction takes up about 60 percent of the MOAC's annual budget, the figures presented in NRC's report were about double the figures presented here, which do not include the budget for irrigation construction as a research activity.

Overall, agricultural research expenditures in Thailand increased almost threefold from 1975 to 1984, with an average annual increase of 13 percent. The rate of increase was much slower during 1976 to 1979, with an average of about 8 percent. Between 1980 and 1984, the average annual increase was much higher at about 17 percent, except in 1982 when the increase was small due to a small increase in the MOAC. On the average, Thailand has been spending about Baht 1,048 million (US $45 million) a year on agricultural research, which is equal to about 0.9 percent of the average total government annual budget over

the same period as shown in Table 2.2, or about 0.6 percent of agricultural GDP at current prices (Table 2.3).

Table 2.1 Total Investments in Agricultural Research

Year	Millions of Baht	Growth Rate (percent)
1975	612.7	-
1976	663.8	8.3
1977	715.6	7.8
1978	762.6	6.6
1979	833.2	9.2
1980	1,003.5	20.5
1981	1,219.3	21.5
1982	1,256.8	3.1
1983	1,609.9	28.1
1984	1,807.7	12.3
Average	1,048.5	13.0

Note: Baht 23 = US $1.

Table 2.2 Total Government Annual Budget for 1975-84

Year	Millions of Baht	Growth Rate (percent)
1975	50,500	-
1976	62,650	24.0
1977	68,790	9.8
1978	81,000	17.7
1979	92,000	13.5
1980	109,000	18.5
1981	140,000	28.4
1982	161,000	15.0
1983	177,000	9.9
1984	192,000	8.4

Source: Budget Bureau.

2.3.2 Research expenditures by research institutions

Between 1975-84, MOAC has been the most important research agency, commanding from 74 to 81 percent of the total research budget, with an annual average of about 75 percent, followed by the Bureau of Universities with about 21 percent, while other research agencies shared from 1 to 3 percent each as shown in Table 2.4. Evidently, there is little change in research expenditure distribution among research agencies over the period.

Within MOAC, the Department of Agriculture, which is responsible for crop research, received from 45 to 57 percent of the Ministry's research budget, averaging 51 percent over the period as shown in Table 2.5. The Department of Fisheries was second, in terms of the research budget allocation, varying from 18 to 27 percent of the total, with an annual average of 21 percent. Other departments in MOAC had been receiving from 3 to 8 percent of the total each. Again, there seems to be only small variation in distribution during the period.

Table 2.3 Agricultural Research Expenditures as Percentage of Agricultural GDP at Current Prices

Year	Agricultural GDP[1] Millions of Baht	Research Expenditures Millions of Baht	Percent of Agr. GDP
1975	94,063	613	0.65
1976	104,657	664	0.63
1977	110,929	716	0.65
1978	129,094	763	0.59
1979	147,076	833	0.57
1980	173,806	1,003	0.58
1981	187,886	1,219	0.65
1982	177,152	1,257	0.71
1983	202,281	1,610	0.80

Notes: [1] NESDB National Income.

Table 2.4 Agricultural Research Expenditures by Research Institutions (millions of Baht)

Year	Total	MOAC	(%)	BOU	(%)	MOI	(%)	MOF	(%)	MOIN	(%)	MOC	(%)	MOSTE	(%)
1975	612.7	497.8	81.3	102.2	16.7	1.7	0.3	2.5	0.4	4.8	0.7	3.6	0.6	-	
1976	663.8	518.5	78.1	130.7	19.7	1.3	0.2	2.8	0.4	7.5	1.1	3.0	0.5	-	
1977	715.7	538.1	75.2	161.8	22.6	1.8	0.3	2.0	0.3	9.0	1.2	3.0	0.4	-	
1978	762.5	568.5	74.6	177.6	23.3	1.7	0.2	2.2	0.3	10.2	1.3	2.3	0.3	-	
1979	833.2	624.4	74.9	191.5	23.0	2.0	0.2	3.0	0.4	9.7	1.2	2.6	0.3	-	
1980	1,003.6	743.5	74.1	239.4	23.8	2.0	0.2	4.1	0.4	11.7	1.2	2.9	0.3	-	
1981	1,219.2	918.0	75.3	278.6	22.8	2.0	0.2	4.6	0.4	12.8	1.0	3.2	0.3	-	
1982	1,256.7	943.5	75.1	280.9	22.4	2.7	0.2	4.3	0.3	13.8	1.1	3.4	0.3	8.1	0.6
1983	1,609.9	1,185.4	73.6	338.2	21.0	3.2	0.2	3.8	0.2	16.5	1.1	4.2	0.3	58.6	3.6
1984	1,807.7	1,415.3	78.3	354.1	19.6	1.8	0.1	5.0	0.3	20.9	1.1	5.0	0.3	5.6	0.3
Avg.	1,048.5	795.3	74.7	225.5	21.2	2.0	0.2	3.4	0.3	11.7	1.1	3.3	0.3	24.1	2.2

Notes: Baht 23 = US $1.00

MOAC Ministry of Agriculture and Cooperatives

BOU Bureau of Universities

MOI Ministry of Interior

MOF Ministry of Finance

MOIn Ministry of Industry

MOC Ministry of Commerce

MOSTE Ministry of Science, Technology and Energy

Table 2.5 Agricultural Research Expenditures by Research Institutions within MOAC

Year	Total	OPS	(%)	OAE	(%)	LDD	(%)	DOA	(%)	DOF	(%)	DOL	(%)	FD	(%)
1975	497.8	70.1	14.1	-	-	26.4	5.3	226.5	45.5	39.4	7.9	10.5	2.1	124.9	25.1
1976	518.4	58.5	11.3	-	-	37.0	7.1	274.4	52.9	43.3	8.4	13.8	2.7	91.4	17.6
1977	538.1	51.5	9.6	-	-	43.1	8.0	303.6	56.4	23.9	4.4	14.4	2.7	101.6	18.9
1978	568.6	56.1	9.9	-	-	43.9	7.7	310.5	54.6	25.4	4.5	17.7	3.1	115.0	20.2
1979	624.4	59.0	9.4	-	-	55.2	8.8	330.4	52.9	35.2	5.6	18.9	3.1	125.7	20.2
1980	743.5	32.6	4.4	10.0	1.3	94.1	12.7	382.8	51.5	39.0	5.2	23.8	3.2	161.2	21.7
1981	918.2	36.9	4.0	12.2	1.3	117.2	12.8	469.1	51.1	60.9	6.6	29.3	3.2	192.6	21.0
1982	943.5	-	-	20.6	2.2	85.5	9.1	473.5	50.2	127.9	13.6	23.6	2.5	212.4	22.4
1983	1,185.5	-	-	41.3	3.5	82.6	7.0	590.4	49.8	127.8	10.7	29.3	2.5	314.1	26.5
1984	1,415.3	-	-	43.4	3.1	92.0	6.5	804.2	56.8	130.0	9.2	30.8	2.2	314.9	22.2
Avg.	795.3	52.1	6.3	25.5	3.1	67.7	8.2	416.5	50.6	65.3	7.9	21.2	2.6	175.4	21.3

Notes: Baht 23 = US $1.00

OPS Office of Permanent Secretary
OAE Office of Agricultural Economics
LDD Land Development Department
DOA Department of Agriculture
DOF Department of Forest
DOL Department of Livestock
FD Department of Fisheries

2.3.3 Research expenditures by subsectors

Research expenditures during 1975-84 are grouped into commodity and non-commodity as shown in Table 2.6. The results show that about 65 to 78 percent of the total research expenditures had been allocated to commodity research, including crops, livestock, fisheries and forestry, with an annual average of about 74.9 percent. The non-commodity research included research activities on land and water development, agroindustries, agricultural economics, agricultural engineering, environmental protection and farming systems, and received a share from 22 to 35 percent of the total with an average of about 25 percent annually. The distribution of research expenditures between commodity and non-commodity research from 1975 to 1984 did not show significant variation.

Within commodity research, the crops subsector consistently received higher shares than other subsectors. Funds allocated to crop research over the period increased from about Baht 209 million in 1975 to about Baht 500 million in 1984 and its share in the total funds for commodity research varied from 51 to 68 percent, with an annual average of about 60 percent.

Funding for fisheries research during the same period was Baht 173 million, on the average, which was about 27 percent of the total funds for commodity research. From 1975 to 1979, the funds for fisheries research did not change very much, varying between Baht 90 million and Baht 23 million. But from 1980 to 1984, there was a clear increasing trend, with an increase from Baht 162 million in 1980 to Baht 311 million in 1983 and Baht 309 million in 1984.

Forestry research ranks third in commodity research with regard to funds allocated. Its share in the total funding varied from 5 to 17 percent. From 1975 to 1980, funds for forestry research varied from Baht 24 million to Baht 43 million, but increased to Baht 61 million in 1981 and Baht 130 million in 1984.

Table 2.6 Agricultural Research Expenditures by Subsector (excluding Universities)

Subsectors	1975 Baht	1975 (%)	1976 Baht	1976 (%)	1977 Baht	1977 (%)	1978 Baht	1978 (%)	1979 Baht	1979 (%)	1980 Baht	1980 (%)	1981 Baht	1981 (%)	1982 Baht	1982 (%)	1983 Baht	1983 (%)	1984 Baht	1984 (%)
Commodities	383.2	75.1	403.4	75.7	431.6	76.7	454.1	76.6	486.6	75.7	595.2	76.3	711.7	74.2	772.4	77.9	973.4	75.3	966.8	65.4
Crops	209.6	54.7	256.1	63.5	293.2	67.9	301.7	66.4	319.6	65.7	370.8	62.3	433.0	60.8	411.9	53.3	505.5	51.9	497.2	51.4
Livestock	10.5	2.7	13.9	3.4	14.4	3.4	17.8	3.9	18.9	3.9	24.0	4.0	29.3	4.1	23.5	3.0	29.3	3.1	30.8	3.2
Fisheries	123.7	32.3	90.1	22.3	100.1	23.2	109.2	24.0	122.9	25.2	161.5	27.1	188.5	26.5	209.1	27.1	310.7	31.9	308.8	31.9
Forestry	39.4	10.3	43.3	10.8	23.9	5.5	25.4	5.7	25.2	5.2	38.9	6.6	60.9	8.6	127.9	16.6	127.9	13.1	130.0	13.5
Non-Commodity	127.1	24.9	129.3	24.3	131.2	23.3	139.1	23.4	156.4	24.3	184.6	23.7	246.7	25.8	219.2	22.1	319.1	24.7	510.2	34.6
Land and Water	26.4	20.8	36.9	28.5	43.0	32.8	43.9	31.5	55.2	35.3	94.1	50.9	117.1	47.5	86.3	39.4	83.3	26.1	92.6	18.1
Agroindustries	1.3	1.0	1.3	1.1	2.1	1.6	3.2	2.4	3.7	2.5	4.2	2.5	6.2	2.5	12.5	5.7	69.4	21.7	12.1	2.5
Agroeconomics	25.7	20.2	26.1	20.2	30.7	23.4	32.2	23.1	37.1	23.7	18.4	9.9	23.7	9.6	33.4	15.2	56.4	17.7	63.5	12.4
Agroengineer	13.2	10.4	13.6	10.5	11.9	9.1	12.7	9.1	13.5	8.6	13.3	7.2	16.7	6.8	-	-	-	-	-	-
Environmental	10.8	8.5	14.7	11.3	13.9	10.6	14.3	10.3	15.4	9.8	17.4	9.4	19.1	7.7	26.1	11.9	33.9	10.6	25.5	5.0
Farming System	49.7	39.1	36.7	28.4	29.6	22.5	32.8	23.6	31.5	20.1	37.2	20.1	63.9	25.9	60.9	27.8	76.1	23.9	316.5	62.0
Total	510.3	100.0	532.7	100.0	562.8	100.0	593.2	100.0	643.0	100.0	779.8	100.0	958.4	100.0	991.6	100.0	1,292.5	100.0	1,477.0	100.0

Livestock research received a relatively small share of the research funds. Over the 1975 to 1984 period, its share varied from 2.7 to 4.1 percent of commodity research funds. Funding increased from Baht 10 million in 1975 to Baht 31 million in 1984.

In non-commodity research, based on funds allocated, land and water development research, agricultural economics, and farming systems research were the most important. On the average, they accounted for about 80 percent of the total funds for non-commodity research. Individually, land and water utilization research received about 33 percent of the total, followed by farming systems research at about 29 percent and agricultural economics at 18 percent. Next to these three groups of research activities, emphasis was on agricultural engineering and environmental studies.

2.3.4 Breakdown of crop research expenditures by crops

Research expenditures for various crops during the period 1975 to 1984 are shown in Table 2.7. The data are obtained from records of various projects. For projects involving more than a single crop, expenditures cannot be further broken down, and in these cases, crops are grouped together. Corn and sorghum are under the same project, although the emphasis has been on corn. Oil crops research emphasizes soybeans, mungbeans and peanuts with some work on castor bean, sunflower and sesame. The "field crops" category includes many cash crops for upland areas, including corn, field beans and tobacco, but excluding rice.

The data presented here are lower than those in the paper presented at the workshop in Singapore (Isarangkura, 1981) for a number of reasons. The Budget Bureau introduced a program budgeting system in 1982, which resulted in regrouping and restructuring research programs and projects. Therefore, to include years before 1982 in time series extending to later dates, it is necessary to regroup research projects earlier than

1982 according to the new program and project structure. The new structure combines several commodities under the same program, which makes estimation of expenditures on individual crops more difficult. It is likely that the research expenditures recorded here under individual crops are underestimated, since they are also included in other categories such as oil crops, root crops, field crops and tree crops, in addition to the amounts that have been separated under specific individual crops. At the subsector level, farming systems research is not included under the crop subsector in this paper, as it also includes livestock, fisheries and woodlot components. Similarly, "multicrops" is not included here as a separate category as it has been included in other classifications. Another factor is that in the new budget classification, a portion of the central administrative cost has been removed from the development budget for various projects, amounting to about 10 to 20 percent of the total budget of each government agency. This represents salaries of government officials located in Bangkok, which vary from one agency to another.

Rice consistently received the highest share of crop research expenditure during the 1975-84 period. The amount of expenditure increased from Baht 40 million in 1975 to Baht 125 million in 1983 and Baht 96 million in 1984 as shown in Table 2.7. Its share in the crop research fund varied from 18 to 25 percent of the total. The second most important crop is rubber, with about 12 percent of the total. The other crops each shared from 1 to 7 percent of the total.

Of all the CGIAR commodities, only cassava and rice are significant with regard to the amount of research funding, with other commodities receiving very little financial support. Rice, as mentioned, has always been the top priority crop. Cassava research expenditure during the 1975 to 1982 period shows a definite increase of Baht 1.3 million in 1975 and Baht 18.8 million in 1982. However, the funding dropped to Baht 5 to 6

Table 2.7 Agricultural Research Expenditures in Crop Subsector

Subsectors	1975		1976		1977		1978		1979		1980		1981		1982		1983		1984	
	Baht	(%)	Baht	(%)	Baht	(%)	Baht	(%)	Baht	(%)	Baht	(%)	Baht	(%)	Baht	(%)	Baht	(%)	Baht	(%)
Rice	39.9	19.0	47.2	18.4	51.5	17.5	53.5	17.7	63.5	19.9	71.2	19.2	83.9	19.4	97.9	23.7	124.5	24.6	96.4	19.4
Cotton	9.6	4.6	10.6	4.1	10.5	3.6	10.1	3.3	10.2	3.2	12.9	3.5	16.1	3.7	17.9	4.3	-	-	-	-
Corn/Sorghum	7.1	3.4	8.5	3.3	15.6	5.3	16.8	5.6	18.5	5.8	18.5	5.0	20.1	4.6	7.1	1.7	26.8	5.3	24.8	5.0
Sugarcane	4.8	2.3	7.5	2.9	9.0	3.1	10.2	3.4	9.7	3.0	11.7	3.2	12.8	3.0	13.8	3.4	16.5	3.3	20.9	4.2
Tobacco	2.5	1.2	2.8	1.1	1.9	0.6	2.2	0.7	3.0	0.9	4.1	1.1	4.6	1.1	4.3	1.0	3.8	0.8	5.0	1.0
Kenaf	3.2	1.5	3.8	1.5	4.1	1.4	3.8	1.3	4.1	1.3	3.8	1.0	4.9	1.1	-	-	-	-	-	-
Rubber	27.8	13.2	34.9	13.6	35.6	12.1	37.5	12.4	40.1	12.5	47.8	12.9	55.9	12.9	27.8	6.7	23.0	4.5	75.1	15.1
Coconut	3.7	1.7	7.3	2.8	7.2	2.5	6.9	2.3	6.2	1.9	7.5	2.0	9.0	2.1	16.4	4.0	-	-	-	-
Mulberry	14.5	6.9	18.5	7.2	20.7	7.1	19.0	6.3	20.3	6.4	23.7	6.4	26.7	6.2	18.8	4.6	10.5	2.1	20.1	4.0
Vegetables	2.5	1.2	2.9	1.1	3.4	1.2	3.2	1.1	3.1	1.0	3.7	1.0	4.1	0.9	1.8	0.4	2.5	0.5	2.7	0.5
Ornamentals	4.1	1.9	5.5	2.1	8.4	2.9	8.9	2.9	10.2	3.2	11.1	3.0	13.4	3.1	17.5	4.2	2.3	0.5	0.7	0.1
Oil Crops[1]	5.6	2.7	6.3	2.5	7.3	2.5	8.1	2.7	8.5	2.7	8.8	2.4	12.0	2.8	-	-	-	-	-	-
Root Crops[2]	1.3	0.6	1.6	1.0	3.3	1.1	3.9	1.3	4.1	1.3	4.5	1.2	5.7	1.3	18.8	4.6	5.1	1.0	6.4	1.3
Field Crops[3]	27.3	13.0	31.1	12.1	44.2	15.1	45.3	15.0	44.8	14.0	51.7	13.9	59.1	13.6	66.8	16.2	119.7	23.7	104.2	21.0
Other Tree[4]	21.5	10.2	27.5	10.7	28.4	9.7	29.2	9.7	25.6	8.0	31.9	8.6	37.9	8.8	36.5	8.9	96.5	19.1	64.9	13.1
Pathology[5]	9.3	4.4	9.7	3.8	10.9	3.7	11.6	3.8	12.1	3.8	14.7	4.0	17.2	4.0	19.7	4.8	19.9	3.9	19.9	4.0
Entomology[6]	10.6	5.0	12.7	4.9	13.9	4.7	14.2	4.7	15.4	4.8	19.9	5.4	22.5	5.2	23.9	5.8	25.4	5.0	28.7	5.8
Chemistry[7]	14.3	7.2	17.7	6.9	17.3	5.9	17.3	5.7	20.2	6.3	23.3	6.3	27.1	6.3	22.9	5.6	29.0	5.7	27.4	5.5
Total	209.6	100.0	256.1	100.0	293.2	100.0	301.7	100.0	319.6	100.0	370.8	100.0	433.0	100.0	411.9	100.0	505.5	100.0	497.2	100.0

Notes:
1 Mainly field beans
2 Mainly cassava
3 Various field crops which cannot be individually separated
4 Include cocoa, coffee and fruitcrops
5 Include several crops
6 Include several crops
7 Includes toxicology, soil and plant analysis

million in 1983 and 1984. On average, research expenditure on cassava amounted to only about 1.5 percent of the total. The continuing high attention to rice can be easily understood as the crop has been the main staple food for the country. The minimum investment in cassava research cannot be easily understood, since cassava is a poor person's crop, grown by northeast farmers who are economically and socially handicapped. The only possible explanation is that researchers tend to aim for yield increase in virtually all of their projects, while with cassava, the government policy calls for reduction in production due to an over-supply situation. This tends to influence negatively the general attitude of researchers. Consequently, fewer research projects on cassava have been implemented, resulting in relatively low investment in cassava research. In addition, the cassava-related research is actually research on other crops to replace cassava.

Corn, sugarcane, rubber and cassava are grown mainly for export. Together they accounted for an average of about 21 percent of total crop research expenditures during 1974-84. Rice commanded an average of about 22 percent per year over the same period. Other crops including cotton, tobacco, kenaf, coconut, mulberry, vegetables, ornamentals, oil crops and other tree crops are primarily for local consumption with their surpluses exported. They are produced in addition to rice to earn extra income. This group of commodities shared about 42 percent of the total crops research annually during the period. In the crop subsector, an average of about 15 percent of the total research funds for crops has been allocated for plant protection and various laboratory chemical studies.

Distribution of research expenditures in the 1975-84 period among the three main groups of commodities does not show much variation. The proportion of research expenditures for rice varied from 17.5 to 24.6 percent, for export crops from 14.1 to 25.6 percent, and for other crops from 39.7 to 46.7 percent.

When research expenditures on the crop subsector are regrouped into food crops (rice, corn/sorghum, vegetables, oil crops, root crops and field crops), tree crops (rubber, coconut, fruit crops, cocoa and coffee) and industrial crops (cotton, sugarcane, tobacco, kenaf, mulberry for silkworm rearing, and ornamentals), the results show that crop research in Thailand emphasizes food crops (44.3 percent of total expenditures), followed by tree crops at 24.2 percent while the industrial crops shared only 16 percent as shown in Table 2.8. During the 1975-84 period, a greater proportion of research investment could be observed for food crops, with little change in tree crops, and a definite decline in industrial crops.

2.3.5 Research expenditures in fisheries

Research expenditures for fisheries increased from Baht 124 million in 1975 to about 309 million in 1984 as shown in Table 2.9. During the period, about 43.4 percent of the total funding on average was allocated to fresh water, 31.9 percent to marine and 24.7 to coastal fisheries. The coastal fisheries, on which about 70 percent of those who fish rely, received little financial support in the late 1970s, but in the early 1980s, greater support was quite evident. In general, there was a shift in emphasis away from both marine and freshwater fisheries to the coastal fisheries.

2.3.6 Livestock research expenditures

Total investment in livestock research increased from Baht 10.5 million in 1975 to Baht 31 million in 1984 as shown in Table 2.10. On average over the 1975-84 period, research in animal diseases received a greater share (58 percent) of research funding than general livestock disciplines (42 percent). Only in the years 1977, 1978 and 1980 was the reverse true. In the livestock subsector, the public sector has shifted its support over the past two decades from poultry and swine to cattle and buffalo, due to the involvement and efficiency of the private sector in poultry and swine production. Therefore, it can be

Table 2.8 Breakdown of Crop Research Expenditures into Food, Tree and Industrial Crops
(Percent of Total Crop Subsector)

Crop	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	Average
Food[1]	39.9	38.4	42.7	43.4	44.7	42.7	42.6	46.6	55.1	47.2	44.3
Tree[2]	25.1	27.1	24.3	24.4	22.4	23.5	23.8	19.6	23.6	28.2	24.2
Industrial[3]	18.4	18.9	18.7	17.9	18.0	18.2	18.2	17.5	6.7	9.3	16.2

Source: Constructed from Table 2.7

Notes: 1 Food Crops include rice, corn/sorghum, vegetables, oil crops, root crops (cassava) and field crops.

2 Tree Crops include rubber, coconut, fruit crops, cocoa and coffee.

3 Industrial Crops include cotton, sugarcane, tobacco, kenaf, mulberry for silk rearing and ornamentals.

Table 2.9 Agricultural Research Expenditures in Fisheries

Commodities	1975		1976		1977		1978		1979		1980		1981		1982		1983		1984	
	Baht	(%)	Baht	(%)	Baht	(%)	Baht	(%)	Baht	(%)	Baht	(%)	Baht	(%)	Baht	(%)	Baht	(%)	Baht	(%)
Marine	37.8	30.6	40.6	45.1	37.7	37.7	41.7	38.2	45.3	36.9	50.8	31.5	56.6	30.0	55.5	26.5	66.1	21.3	64.0	20.7
Coastal	9.7	7.8	12.9	14.3	24.3	24.3	24.3	22.3	26.5	21.6	53.9	33.4	64.0	34.0	70.3	33.6	73.1	23.5	100.7	32.6
Freshwater	76.2	61.6	36.6	40.6	38.1	38.1	43.2	39.6	51.1	41.6	56.8	35.2	67.9	36.0	83.3	39.8	171.5	55.2	144.1	46.7
Total	123.7	100.0	90.1	100.0	100.1	100.0	109.2	100.0	122.9	100.0	161.5	100.0	188.5	100.0	209.1	100.0	310.7	100.0	308.8	100.0

Table 2.10 Agricultural Research Expenditures in Livestock

Commodities	1975		1976		1977		1978		1979		1980		1981		1982		1983		1984	
	Baht	(%)	Baht	(%)	Baht	(%)	Baht	(%)	Baht	(%)	Baht	(%)	Baht	(%)	Baht	(%)	Baht	(%)	Baht	(%)
Health[1]	6.9	65.7	7.0	54.0	7.0	48.6	8.6	48.3	9.8	51.9	11.6	48.3	15.1	51.5	16.6	70.6	20.7	70.7	21.8	70.8
Husbandry[2]	3.6	34.3	6.4	46.0	7.4	51.4	9.2	51.7	9.1	48.1	12.4	51.7	14.2	48.5	6.9	29.4	8.6	29.3	9.0	29.2
Total	10.5	100.0	13.9	100.0	14.4	100.0	17.8	100.0	18.9	100.0	24.0	100.0	29.3	100.0	23.5	100.0	29.3	100.0	30.8	100.0

Notes: 1 Veterinary Science

2 Breed and feed improvement.

said that most public investment in livestock research between 1975 and 1984 was for cattle and buffalo improvement. However, the recording system did not permit separation of research expenditures on an individual commodity basis.

2.4 Personnel in agricultural research

2.4.1 Total number of researchers in agriculture

The total number of researchers in agriculture in all public institutions carrying out research increased from 5,504 in 1975 to 7,954 in 1984 as shown in Table 2.11. The number included all government officials and permanent and temporary employees on the projects. The increase in personnel was at the average rate of 4.3 percent per year. The rate of increase was highest during 1975 to 1980. After that, there were decreases in some years and increases in others, which more or less evened out the net effect. Such changes were in line with government policies to limit expansion of government officials to 2 percent per year and to reduce the number of temporary employees in government service.

2.4.2 Number of researchers by institution

A breakdown of researchers engaged in agricultural research activities during 1975 to 1984 by research institutions is presented in Table 2.12. On average, about 62 percent of the total were in MOAC, 31 percent in the Bureau of Universities, 3 percent in the Ministry of Industry, another 2.5 percent in the Ministry of Finance and very small percentages in other research institutes. During 1975 to 1984, the number in MOAC increased about one and one-half times, while that in the Bureau of Universities doubled. Table 2.13 gives the breakdown of MOAC researchers by department.

2.4.3 Number of researchers by subsector

More agricultural researchers were in commodity research programs than in non-commodity ones, with about 75 percent of the

total researchers in commodity research averaged over the 1975-84 period as shown in Table 2.14. Within the commodity programs, more than 60 percent of the researchers worked on crops. For the non-commodity programs, land and water development and agricultural economics had the most researchers.

The number of agricultural researchers working on various crops from 1975 to 1984 is shown in Table 2.15. The number is highest in rice research, rubber, field crops, sugarcane, tobacco, mulberry and tree crops.

Table 2.11 Total Number of Research Scientists in Agriculture

Year	Number	Growth Rate
1975	5,504	-
1976	5,943	8.0
1977	6,285	5.3
1978	6,635	5.6
1979	7,289	9.9
1980	8,052	10.5
1981	7,882	-2.1
1982	8,356	6.0
1983	8,294	-0.7
1984	7,954	-4.1
Average	7,219	4.3

Source: Constructed from research projects identified.

Table 2.12 Number of Research Scientisits by Research Institutions

Year	Total	MOAC	(%)	BOU	(%)	MOI	(%)	MOF	(%)	MOIn	(%)	MOC	(%)	MOSTE	(%)
1975	5,504	3,717	67.5	1,428	25.9	49	0.9	101	1.8	159	2.9	50	0.9	-	-
1976	5,943	3,885	65.4	1,681	28.3	49	0.8	101	1.7	177	3.0	50	0.8	-	-
1977	6,285	3,994	63.5	1,888	30.0	49	0.8	101	1.6	203	3.2	50	0.8	-	-
1978	6,635	4,230	63.8	1,992	30.0	49	0.7	101	1.5	215	3.2	48	0.7	-	-
1979	7,289	4,621	63.4	2,129	29.2	49	0.7	224	3.1	218	3.0	48	0.7	_	_
1980	8,052	5,119	63.6	2,378	29.5	49	0.6	224	2.8	223	2.8	59	0.7	_	_
1981	7,882	4,767	60.5	2,574	32.7	49	0.6	224	2.8	208	2.6	59	0.7	_	_
1982	8,356	5,058	60.5	2,755	33.0	49	0.6	224	2.7	211	2.5	59	0.7	_	_
1983	8,294	4,981	60.1	2,755	33.2	49	0.6	224	2.7	226	2.7	59	0.7	_	_
1984	7,954	4,637	58.3	2,755	34.6	49	0.6	230	2.9	224	2.8	59	0.7	_	_
Average	7,219	4,500	62.3	2,233	30.9	49	0.7	175	2.4	206	2.9	54	0.7	_	_

Notes:
- MOAC Ministry of Agriculture and Cooperatives
- BOU Bureau of Universities
- MOI Ministry of Interior
- MOF Ministry of Finance
- MOIn Ministry of Industry
- MOC Ministry of Commerce
- MOSTE Ministry of Science, Technology and Energy

Table 2.13 Number of Research Scientists in MOAC

Year	Total	OPS	OAE	LDD	DOA	DOF	DOL	FD
1975	3,717	409	-	425	1,945	214	89	635
1976	3,885	435	-	425	2,073	214	89	649
1977	3,994	500	-	360	2,184	214	102	634
1978	4,230	534	-	339	2,365	214	107	671
1979	4,612	611	-	519	2,420	184	134	753
1980	5,119	235	125	517	3,098	184	167	793
1981	4,767	247	132	525	2,596	184	192	891
1982	5,058	-	129	519	2,867	397	221	925
1983	4,981	-	129	519	2,772	397	221	943
1984	4,637	-	129	519	2,428	397	221	943
Average	4,500	424	129	467	2,475	260	154	784

Notes:

OPS	Office of Permanent Secretary
OAE	Office of Agricultural Economics
LDD	Land Development Department
DOA	Department of Agriculture
DOF	Department of Forest
DOL	Department of Livestock
FD	Department of Fisheries

Table 2.14 Number of Research Scientists by Subsector (excluding Universities)

Subsectors	1975 No.	1975 (%)	1976 No.	1976 (%)	1977 No.	1977 (%)	1978 No.	1978 (%)	1979 No.	1979 (%)	1980 No.	1980 (%)	1981 No.	1981 (%)	1982 No.	1982 (%)	1983 No.	1983 (%)	1984 No.	1984 (%)
Commodities	2,903	71.1	3,059	72.1	3,194	72.5	3,427	73.7	3,660	72.5	3,894	69.3	4,008	75.6	4,538	81.0	4,577	82.6	4,207	80.9
Crops	1,985		2,128		2,266		2,457		2,634		2,790		2,782		3,036		3,056		2,686	
Livestock	89		89		102		107		134		167		192		221		221		221	
Fisheries	615		628		612		649		708		753		850		884		903		903	
Forestry	214		214		214		214		184		184		184		397		397		397	
Non-Commodity	1,177	28.9	1,182	27.9	1,208	27.5	1,223	26.3	1,387	27.5	1,721	30.7	1,293	24.4	1,062	19.0	962	17.4	992	19.1
Land/Water	425		425		360		339		519		517		525		519		519		519	
Agroindustry	20		21		22		22		45		46		46		46		46		46	
Agroeconomics	429		421		441		431		355		624		177		259		159		189	
Agroengineer	62		67		70		74		78		90		80		-		-		-	
Environmental	162		161		170		170		172		182		182		182		182		182	
Farming System	79		87		145		187		218		262		283		56		56		56	
Total	4,080	100.0	4,241	100.0	4,402	100.0	4,650	100.0	5,047	100.0	5,615	100.0	5,301	100.0	5,600	100.0	5,539	100.0	5,199	100.0

Table 2.15 Number of Agricultural Researchers by Crops

Commodities	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Rice	380	419	426	461	471	486	486	490	539	533
Cotton	19	19	20	20	20	20	20	20	-	-
Corn/Sorghum	11	18	44	48	51	51	51	18	18	18
Sugarcane	159	177	203	215	218	223	208	211	226	224
Tobacco	101	101	101	101	224	224	224	224	224	230
Kenaf	3	6	7	7	8	8	8	-	-	-
Rubber	230	245	248	266	271	282	282	351	351	349
Coconut	17	15	21	21	23	25	25	74	-	-
Mulberry	122	128	130	140	142	150	157	162	163	154
Vegetables	17	24	19	18	18	18	18	15	15	15
Ornamentals	31	34	37	45	45	45	45	100	100	4
Oil Crops	6	10	10	11	11	11	11	-	-	-
Root Crops	10	12	13	14	14	14	14	14	14	14
Other Field Crops	285	295	309	337	353	392	392	438	459	422
Other Tree Crops	93	97	110	131	141	165	165	213	240	256
Pathology	138	148	158	177	177	203	203	205	205	138
Entomology	188	197	220	250	250	264	264	275	276	153
Chemistry	175	183	190	195	197	209	209	226	226	176
Total	1,985	2,128	2,266	2,457	2,634	2,790	2,782	3,036	3,056	2,686

Researchers working on fisheries increased in number from 615 in 1975 to 903 in 1984 as shown in Table 2.16, with the majority in freshwater fisheries. In the late 1970s, there were more researchers in marine than in coastal fisheries, but toward the mid-80s, the number equalized, indicating a recent shift to coastal fisheries research, while the freshwater fisheries research maintains its importance. Such trends were in line with overall fisheries strategy, which called for more emphasis on coastal fisheries due to the impact on the marine catch of the 200 mile exclusive economic zone, and for greater attention to freshwater fisheries for improving protein consumption among the rural poor.

The number of researchers in livestock research also increased slowly from 89 in 1975 to 221 in 1984 as shown in Table 2.17. In 1975, only about 28 percent of the total researchers were in animal husbandry while 70 percent were in animal health, but toward the mid-1980s relatively more researchers were added to animal husbandry research than to animal health, so that by 1984, the number of researchers in animal husbandry was about 42 percent of the total.

2.5 Foreign assistance in agricultural research

Between 1975 and 1984, there were a number of bilateral and multilateral agencies providing assistance in various forms to Thailand agricultural research. To quantify the assistance in monetary terms is far more difficult than to classify research expenditures for various commodities. The records are not well-circulated and research components are usually part of the overall agricultural development projects. Budget allocations within each project could be changed with time through mutual agreement between the two parties.

Table 2.18 presents an attempt to collect as much data as possible on financial assistance received from various donor agencies during 1975 to 1984. From 1975 to 1980, foreign

Table 2.16 Number of Research Scientists in Fisheries Research

Commodities	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Marine	233	241	173	173	216	222	247	162	181	181
Coastal	32	39	107	132	160	167	206	187	187	187
Freshwater	350	348	332	344	332	364	397	535	535	535
Total	615	628	612	649	708	753	850	884	903	903

Table 2.17 Number of Research Scientists in Livestock Research

Item	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Health	69	69	78	72	90	119	129	156	156	156
Husbandry	20	20	24	35	44	48	63	65	65	65
Total	89	89	102	107	134	167	192	221	221	221

Table 2.18 Foreign Assistance in Agricultural Research
(million Baht)

Subsectors	1975 Baht	1975 (%)	1976 Baht	1976 (%)	1977 Baht	1977 (%)	1978 Baht	1978 (%)	1979 Baht	1979 (%)	1980 Baht	1980 (%)	1981 Baht	1981 (%)	1982 Baht	1982 (%)	1983 Baht	1983 (%)	1984 Baht	1984 (%)
Commodities	14.0	100.0	12.9	100.0	17.4	100.0	18.6	100.0	22.3	100.0	44.8	96.3	288.6	92.2	319.9	79.2	322.2	86.9	217.0	69.1
Crops	10.0		10.0		13.0		13.3		13.3		13.3		250.6		240.6		263.5		139.9	
Fisheries	S		S		S		S		S		23.3		23.0		30.2		32.2		19.9	
Livestock	S		S		S		S		S		S		S		S		S		S	
Forestry	4.0		2.9		4.4		5.3		9.0		8.2		15.0		49.1		53.5		57.2	
Non-Commodity	-	-	-	-	-	-	-	-	-	-	1.7	0.7	24.4	7.8	84.1	20.8	48.6	13.1	96.9	30.9
Agroengineer	S		S		S		S		S		S		11.1		16.6		14.1		13.6	
Agroindustry	S		S		S		S		S		S		S		50.0		S		50.0	
Farming System	S		S		S		S		S		1.7		13.3		17.5		34.5		33.3	
Total	14.0	100.0	12.9	100.0	17.4	100.0	18.6	100.0	22.3	100.0	46.5	100.0	313.0	100.0	404.0	100.0	370.8	100.0	313.9	100.0
Growth Rate	-		-7.9		34.9		6.9		19.9		108.5		573.1		29.1		-8.2		-15.3	
% of National Total	2.3		1.9		2.4		2.4		2.7		4.6		25.7		32.2		23.0		17.4	

Note: S = Small amount, less than Baht 0.1 million

assistance was small, with totals varying from 1.9 to 4.6 percent of total research expenditures. But from 1981 onward, foreign assistance increased from about 17.4 to 32.2 percent of the total research expenditures. Such increase was caused by the launching of the National Agricultural Research Project by the Department of Agriculture with assistance from the World Bank, the International Fund for Agricultural Development (IFAD) and the Australian government. The total project cost, for its 8-year duration, was Baht 2,200 million. Since the project is only concerned with crop research, crop research expenditures have accordingly increased since 1981.

USAID contributed significantly to the national agricultural research system in the 1960s through its grant assistance in research personnel development in MOAC. Even though no definite figure can be reported here, it is certain that most of the Thai researchers did their graduate programs in the United States.

The World Bank has been involved in the agricultural extension system in Thailand through its loan for the National Extension Project starting in 1978 and lasting until 1984, by which time the T & V system was introduced. The World Bank then followed, with the National Agricultural Research Project in 1981, under which the Department of Agriculture has reorganized administratively, emphasizing decentralization of research closer to the farmers and upgrading of selected research stations in terms of physical facilities and personnel. In the project preparation phase, institutional constraints were identified and FAO, UNDP and ISNAR have been providing consultants to clarify the problems and make recommendations to overcome the problems which were selectively included in the final project document. Under the project, both IFAD and ADAB have important roles to play. The Australian government committed itself to provide about 7 million Australian dollers for technical assistance which includes consultancy services and fellowships.

The Japanese government has given assistance in soybean research, cooperates with Thai researchers in rice research, and provides financial support to improve animal disease control, particularly in foot and mouth diseases, and for corn improvement.

The Danish government concentrates its assistance mainly in dairy improvement and storage facilities. IDRC, the Ford Foundation and the Agricultural Development Council (ADC) have given relatively small funding to Thai researchers to tackle specific development issues such as small-scale irrigation utilization, cassava soil fertility problems, land use patterns in specific regions of the country, fisheries for small-scale fish raisers and so on.

Most of the assistance from foreign sources has been directed to development projects rather than to purely agricultural projects. Many of the projects also include research activity as a small component. Therefore, the non-CGIAR donor agencies which have contributed significantly to the overall national agricultural research system are USAID, in research personnel development, and the World Bank, IFAD and the Australian government in restructuring the Departments of Agriculture and Agricultural Extension.

It should also be mentioned here that various universities have been receiving assistance from the Rockefeller Foundation, the Ford Foundation, IDRC, ADC and the Japanese government in terms of physical facilities, scholarships and financial support to carry out research projects.

Under the CGIAR system, IRRI, CIMMYT, ICRISAT, CIAT and IBPGR are the international research organizations more commonly known to the Thai researchers than the others under the same system. The impact of these agencies on the national agricultural research system and on the agricultural sector as a

whole, and their relationship with assistance from the non-CGIAR agencies are presented in other sections.

3 Perceptions in the National Agricultural Research System of the International Agricultural Research Centers

3.1 Conduct of the interviews

A total of 34 interviews were conducted with directors and deputy directors of the main government research agencies and programs, the planning office of the MOAC, the deans and principal researchers in the agricultural faculty of the universities, the principal officers in the National Extension Program, key personnel in private sector firms, and with the principal officers in the central planning agency. Since the Department of Agriculture, MOAC, is the main research agency and has been involved with a number of IARCs, the most samples were drawn from that department. In addition, foreign experts in the IARCs' projects were also consulted but were excluded from the data tabulation.

3.2 Results of the interviews

The purpose of the interviews was to document perceptions of the directors and principal scientists in the NARS of the contribution the IARCs have made to research capacity in Thailand through: (1) the flow of information from the IARCs; (2) the provision of genetic materials; (3) the enhancement of human capital; and (4) contributions to research methodologies, and approaches to problem solving.

The responses to questions are summarized in the rest of this section. Of those interviewed, 42.8 percent were collaborating with IRRI, 14.3 with CIMMYT, 14.3 with CIAT, 3.6 with IBPGR and 25 percent with more than one IARC, but mainly IRRI, CIMMYT and CIAT.

3.2.1 Summary of questions and number of responses

Forms of Assistance received from the IARCs:

Experts	34
Research funds	7
Training courses	24
Academic programs	10
Equipment	11
Genetic materials	13
Technical publications	23
Workshop/conference	19

Forms of assistance considered most useful:

Genetic material	20
Joint research with expert	18
Technical publications	16
Workshops/conferences	12
Training locally	10
Research funding	-
Academic program	-
Equipment	-

Collaboration with IARCs has lead to:

Research methodology improvement	22
Better knowledge of global research activities	15
Better problem identification	14
More attention to agroecological zones	10
More research funds for IARC commodities	10
More interest in farming systems	9
Changes in research policy	8
Changes in emphasis given to commodities	7
Changes in farm evaluation of technology	6
Changes in research organization	3

Collaborative programs with the IARCs which have lead to adoption of new varieties, practices, techniques by farmers and processors:

IRRI	16
CIMMYT	9
CIAT	4
ICRISAT	3
IBPGR	1

Additional information was given that CIMMYT has provided training to a number of scientists who are now working in seed production and varietal improvement of crops in private sector firms.

Quality of services provided by IARCs:

Very good	12
Good	16
Fair	5
Poor	-
Don't know	1

Are there alternative sources of these services?

Yes	12
No	9
Don't know	13

Recognizing the specialized fields of crop research in IARCs with which Thailand is involved, 26.5 percent of the persons interviewed did not believe that similar assistance could be obtained elsewhere.

Has collaboration with IARCs imposed additional burdens on your research?

Yes	12
No	18
Don't know	4

Have the services of the IARCs changed as your needs have changed?

Yes	11
No	12
Don't know	11

The reason given for answering "No" was the belief that IARCs are governed by their own policies and unless there was access to policymaking bodies of the Centers, services to the kingdom could not be changed.

Are there adequate mechanisms for you to express your needs to the IARCs?

Yes	19
No	9
Don't know	6

Many expressed that contacts with experts positioned in Thailand were vehicles through which to express their ideas to the IARCs.

Are the needs and priorities of agricultural research in Thailand being reflected in collaborative work with the IARCs?

Yes	20
No	5
Don't know	9

National agricultural research priorities could not be precisely quoted by many persons interviewed.

What are the areas of concern not being addressed by the Centers?

Post-harvest technology	2
Production improvement for industrial use	1
Cost of production reduction	1
Varietal conservation	1
Production of hybrid rice	1

Improvement of traditional farming systems	1
Basic research	1
Socioeconomic constraints to adoption of technology	1
Development communication in rural areas	1
Agricultural research by the private sector	1

Suggestions for future activities of the Centers:

Expand their services	2
More exchanges of ideas and research results among researchers	2
More emphasis on low-cost technologies	1
Increase their direct assistance to universities, particularly regional ones	3
Organize more workshops	1
Should also provide assistance to the private sector	1
Concentrate on developing new genetic lines	1
More training courses	2
Increase services in genetic materials	3

Economic policy and institutional arrangements which have impact on the generation and diffusion of new agricultural technologies:

Impeded technology generation -	
Seed exchange program reduces chance for obtaining new varieties	1
Import restrictions on crop seed	1
Impeded technology diffusion -	
Price and market uncertainties	7
Farm input prices and market undertainties	1
Inadequate institutional credit	2
Lack of local producer protection	1
Lack of appropriate technology	2
Public sector competes with private sector	1
Export taxes on farm products	1

Unfavorable relative prices of farm inputs to outputs	2
Competition with off-farm employment	1
Better yield varieties	3
Technology which reduced cash investment	1
Training for extension workers	1

Following are the new developments which are already available or may become available for extension in the near future:

Rice: There is expectation that R.D. 13 could be improved in eating quality to suit people in the south which is at present a rice deficit region.

Corn: Releasing of No. 2301, which is somewhat drought resistant with cooperation from the private sector in seed distribution, should be able to reduce early crop failure due to chronic shortage of rainfall during the early rainy season. This has often lead to loss of corn seed by the farmers who then have to buy more seed for replanting.

Cassava: Rayong 2 and 3, varieties released in 1983, could help in reduction of losses due to bacterial disease and could serve to increase protein content for animal feed. Biotechnology to increase the protein content of cassava through addition of yeast would also increase the feed quality of cassava. However, little impact is expected from these new developments as the cassava crop is mainly grown by poor farmers, and local utilization of cassava is less than 10 percent of total production.

Wheat and Barley: researchers believe that suitable varieties have been developed, but the problem is in extension work.

3.3 Discussion

3.3.1 General impressions

Virtually all persons interviewed expressed appreciation for the work of the IARCs, even though they considered assistance from the IARCs, in monetary terms, as small in relation to that received from other donor agencies. The word "collaboration" has been more commonly used than "assistance" by the persons interviewed.

IRRI is the best known center among Thai research managers and researchers because of the well-publicized "Green Revolution," the R.D. rice series, its long history in Thailand and its relatively close proximity.

Since there is little clear sense of national priorities in agricultural research, the researchers tend to develop deep knowledge in specific commodities but cannot relate their work to overall needs of the farmers and the nation. They lack quantifiable knowledge of the impact of new technology on farmers.

Knowledge of the persons interviewed about the policies and directives of the IARCs tends to be general rather than specific. Most persons know about the crops of interest to each IARC, but changes in emphasis over time were unclear.

Some weaknesses in the NARS, particularly the lack of a national approach to agricultural research, have led to problems in coordination of research activities and in linking research and extension. Consequently, improving the capacity to absorb improvements needs urgent attention.

3.3.2 Services from IARCs

The services most appreciated are in genetic materials, joint research with experts, technical publications providing information about global or regional research activities and

training at IARCs. Comparing these with the forms of services received, the following conclusions can be made:

(1) service in genetic material should be improved either through better distribution within the kingdom or from IARCs;
(2) joint research activities between Thai researchers and experts should continue to be encouraged;
(3) technical publications are much needed and their circulation should be expanded;
(4) training at IARCs is preferred over training locally;
(5) services in other forms could be minimized;
(6) quality of services has been classified mainly as good and very good.

3.3.3 Impact of collaboration with IARCs and NARS

The collaborations have led to an overall improvement in the NARS by the improvement of researchers, as reflected in the results of the interviews, which indicate improvement in research methodology and planning, better knowledge of global research activities, which allows short cuts in applied research, greater consideration of the need to treat farms as economic units, and greater concern for agroecological replicability. This improvement has been brought about with the help of training, technical information and genetic material services from the IARCs. However, those interviewed expressed belief that such services have not resulted in changes in research organization, which is not a very correct conclusion. It is not widely known that under the National Agricultural Research Project, established by a loan from the World Bank, ISNAR provided consultancy services in reorganization of the Department of Agriculture. Therefore, the IARCs have also caused changes in agricultural research organization.

3.3.4 Suggestions for future work or improvement of IARCs

There are no concrete suggestions for improvement of future

work by the IARCs, except for requests for direct support to regional universities and the possibility of providing direct assistance to the private sector. This situation indicates satisfaction by the persons or agencies collaborating with the IARCs as their counterparts. Those further down the line, who receive less assistance, have the right to complain. It is interesting to note that although the universities have research personnel qualified to conduct research programs, they have much less research funding than their counterparts in the MOAC.

3.3.5 Relative impact on NARS of various IARCs

There is no doubt that IRRI has been regarded as the most outstanding among all IARCs for the reasons given. The other centers such as CIMMYT and CIAT are still new to the majority of Thai researchers. Opinions have been given that the locality of the IARCs is another important factor since cost of collaboration increases with distance, which reduces participation. The general attractiveness of the countries in which the IARCs are situated also influences the willingness of participants. Among all the IARCs, IRRI is closest to Thailand, which has always given high priority to rice production and improvemement.

3.3.6 Economic policy and institutional arrangements which have impact on technology generation and diffusion

It is quite natural for government officials whose responsibility it is to promote production to blame marketing as an obstacle to extension efforts. This is reflected in the results of the interviews. Few other persons would consider marketing to be a constraint. Thailand is a food surplus country, and the government has been faced with an insufficient budget to carry out direct purchasing of farm commodities or even rice alone. Therefore, the policy has been to promote free market enterprise, and the main strategy has been export-oriented. Under such circumstances, there is need to diversify production according to demand, and to improve productivity and quality for better competitiveness in the world market.

Therefore, the lack of appropriate agricultural technology is very critical.

4 Views of Professionals in Commodity Programs on the Collaboration with the International Agricultural Research Centers

4.1 Conduct of the interviews

Since IRRI, CIMMYT and CIAT are the IARCs with which Thai researchers have been collaborating the most, only the professionals in these three programs were interviewed, using questionnaires provided by the CGIAR. Altogether, 30 persons were interviewed with 10 from IRRI, CIMMYT and CIAT programs.

4.2 Results of the interviews

4.2.1 Basic facts about the professionals interviewed

Educational level	PhD	MS	BS	Other
Percent of total	32	56	12	-

Eighty percent had their graduate education abroad, with only 20 percent from the local universities.

Year of graduation (in percent)

1950s	12
1960s	16
1970s	64
1980s	8

Principal professional activities (in percent)

Plant breeding	40
Grain technology research	4
General crop research	28
Entomology Research	8
Soil science research	4
Research and teaching	16

Major commodities (percentage of scientists involved)

Rice	44
Cassava	28
Corn	36
Wheat and Barley	8
Sorghum	16
Animal	8
Vegetables	4

The numbers represent the percentage of scientists involved in the various commodities, however, some stated more than one commodity.

4.2.2 Knowledge of CGIAR system as a whole (in percent)

No knowledge	28
Slight	28
Considerable	44
Very thorough	0

4.2.3 Judgment on overall level of activity of the IARCs in Thailand (in percent)

Don't know	20
Inactive	8
Moderately active	52
Very active	20

4.2.4 Grading of IARCs in Thailand (in percent)

The professionals interviewed scored their priorities from one to three, with three representing the highest priority.

	IRRI	CIMMYT	CIAT	IBPGR	ICRISAT
Most active	51	30	9	3	7
Most practical use	49	32	9	5	5
Most helpful in building research capacity	52	25	15	5	3

4.2.5 Frequencies and the year of first contact with the IARCs

Table 4.1 shows percentages of professionals who have made the most frequent contact with the centers and the distribution of the period of time for the first contact.

Table 4.1 Contact with the Centers

		Year of first contact					
		Early 1960s	Late 1960s	Early 1970s	Late 1970s	Early 1980s	Cannot Remember
Most contact with:							
IRRI	47.8	18.2	27.3	36.4	9.1	-	9.0
CIMMYT	30.4	-	14.3	14.3	28.6	42.8	-
CIAT	21.8	-	-	-	80.0	20.0	-
Some contact with:							
IRRI	21.7	-	-	20	20	40	20
CIMMYT	4.3	-	-	-	-	100	-
CIAT	4.3	-	-	100	-	-	-
IBPGR	4.3	-	-	-	-	100	-
ICRISAT	8.6	-	-	100	-	-	-
None	56.8	-	-	-	-	-	-

These results show that IRRI, CIMMYT and CIAT were the centers most contacted by Thai researchers. As far as the year of first contact is cocnerned, almost 20 percent of the researchers contacted IRRI as early as the early 1960s. Initial contact with CIMMYT started in the late 1960s, and CIAT in the late 1970s, showing that involvement with the centers started long before they set up regional offices in Thailand.

4.2.6 Activities with the centers

Visiting the centers:

Only 28 percent of the scientists had not visited the

centers. The total number of visits was 32, out of which 59.4 percent were to IRRI, 18.9 to CIMMYT, 15.6 to ICRISAT and 6.1 to CIAT. Of the total sample, 28 percent visited more than once. The visits to CIMMYT were all during 1982-84, for ICRISAT from 1973 to 1984 and for IRRI 5.3 percent of the visits were in the 1960s, 21.1 in the 1970s, 47.4 in the 1980s and 26.2 "cannot remember."

Attending workshops/conferences at the centers:

Forty-four percent of the researchers had never attended workshops at the centers, while 20 percent of them had attended more than once. There were altogether 19 visits recorded, of which 68.4 percent were at IRRI, 10.5 at CIMMYT, 10.5 at CIAT, 5.3 and ICRISAT and another 5.3 at IBPGR. Of the total visits, 79.8 percent were during 1980-84 with the rest in the 1970s.

Participating in training courses at the centers:

About 60 percent of the researchers had not attended training courses at the centers. Only 11 visits were recorded, 5 at IRRI, 3 at CIAT, 2 at CIMMYT and 1 at ICRISAT. Among these researchers, only one attended courses at two different centers. Visits to CIAT were in 1984, to ICRISAT in 1979, to CIMMYT in 1979 and 1984, and to IRRI in 1963, 1972, 1980 and 1981.

Receiving materials from the centers:

Only 12 percent had not received materials from the centers. Of those who received materials, 22.7 percent had received them from more than one center. Percentages of the number of times the respective centers were recorded are as follows (in percent):

IRRI	36.7
CIMMYT	30.0
CIAT	20.0
ICRISAT	10.0
IITA	3.3

The service received from IRRI started in 1963, from CIMMYT in 1976, from CIAT in 1975 and from ICRISAT in 1964.

Receiving reports and newsletters from the centers:

Only 12 percent of the researchers had not received the reports and newsletters. For those who received the reports, most of them could not recall the year of the first service received. Out of those who received, about 27 percent had been receiving from more than one center.

Visits by staff from centers:

About 72 percent of the researchers had been visited by staff from the centers. Of those who had been visited, 27.8 percent were visited more than once, and 38.9 percent were visited many times a year. Relative frequencies of the visits among the centers, expressed as percentages of the total number of visits, are presented below:

IRRI	40.7
CIMMYT	25.9
CIAT	14.8
ICRISAT	11.2
IITA	7.4

4.2.7 Importance of the Centers' activities

The researchers interviewed were asked to rate the main activities of the centers according to the importance to their work. Table 4.2 presents the data as percent of the total sample.

The results show strong recognition of training as an important activity of the centers, with information and materials received also highly regarded.

Table 4.2 Center Activities and Importance to Researchers' Work

Activities	Importance to Their Work			
	No Contact	Minor	Some	Very
Attending workshops/ conferences	40	4	16	40
Participating in training	24	-	20	56
Receiving materials	20	-	36	44
Receiving newsletters/reports	12	-	44	44
Visits by staff from centers	28	4	44	24
Research techniques/approaches	32	4	36	28

4.2.8 The single most important activity of the Centers and the overall quality of service

The response to the question presented as percentage of the sample was as follows:

Single most important activity (in percent):

Plant materials	52
Workshops/conferences	16
Training courses	8
Research techniques/approaches	12
Newsletters/reports	8
Visits by staff from Centers	4

Overall quality of service (in percent):

Poor	-
Fair	8
Good	60
Excellent	32

4.2.9 Importance of services provided by non-CGIAR agencies

Responses to the question on the importance of non-CGIAR

agencies are tabulated as a percentage of the total interviews and presented in Table 4.3.

Table 4.3 Importance of Non-CGIAR Agencies' Activities

		Importance		
	No Contact	Minor	Some	Very
Workshops/conferences	64	4	32	28
Arranging postgraduate study	68	4	16	12
Training courses	44	8	20	28
Newsletters/reports	32	12	32	24
Others				
Research grants	-	-	-	4
Research techniques	-	-	-	4

The non-CGIAR agencies with the most contact are the Austrailian CSIRO, The World Bank, Australian Development Assistance Bureau, IDRC, SEARCA, ACIAR, Ford Foundation, Rockefeller Foundation, Agricultural Development Council, JICA (Japan), IADS, U.S. National Agricultural Library, U.S. National Academy of Science, NIFTAL and International Atomic Energy Agency.

The non-CGIAR agencies with some contact are FAO, ASPAC, East-West Center, National Institute of Genetics, ACIAR, ADC and the BNF Resource Center.

4.2.10 Some comments on the role of the Centers

- there is a gap between real problems at the national level and the work the Centers are doing;

- research at the Centers should recognize the need for local specificity;

- the Centers' staff stationed in the region can help to generate local interest;

- effectiveness of the Centers is weakened by weak NARS;

- should be more interaction between universities and the Centers;

- the Centers should pay more attention to poverty eradication;

- the Centers should not be involved in politics;

- distribution of services from the Centers should be based on fair and equal criteria;

- need to strengthen relationship between the Centers' staff and the national scientists;

- the Centers should pay more attention to the private sector;

- should improve newsletter circulation to cover more scientists free of charge, but full scientific reports should be charged at minimal price and the list of reports should be included in the newsletters;

- there should be one coordinating body overseeing the work of all Centers.

4.3 Discussion

4.3.1 The professionals in the collaborative programs

Interesting features about the scientists collaborating with the Centers are that (a) 80 percent of them earned their highest degree abroad and (b) 64 percent of them graduated in the 1970s. Therefore, language and age should not be a problem to the

collaborative effort. However, all of them are biological scientists, which indicates a lack of a real multidisciplinary approach to technological development and which explains the complaints from the extension officials about the lack of socio-economic analysis of the research results. The suggestion has also been made that economists and sociologists could be effectively used at regional research and extension centers in program and project formulation and evaluation (Paarlberg, 1982).

4.3.2 Knowledge of the CGIAR system as a whole

None of the researchers interviewed really and fully know about the overall CGIAR system. Therefore, their judgment on the overall level of activity of the IARCs in Thailand is based on their knowledge of the specific IARCs they are involved with. Again, as in the case of research administrators, the judgment of the researchers on the level of activity of IARCs has been quite favorable. The popularity of IRRI is confirmed by the researchers, as by the research administrators. CIMMYT is not far behind, while CIAT, IBPGR and ICRISAT are probably still small in their scope of assistance. Another factor is the longer history of IRRI programs involving Thai researchers, which date back to the early 1960s, while CIMMYT started its contact later in the 1960s and CIAT in the late 1970s.

4.3.3 Services from the Centers

Thailand has received all forms of services the Centers offer in varying degree. The results of the interviews did not really indicate the single most important activity or service in the opinion of the researchers. When they were asked to rate the whole range of services, it seemed as though training courses were the most important. But when asked to identify the single most important activity, genetic material stood out clearly as the most important one. The difference could probably be explained by the different targets of the services. Training improves researchers' capability, while genetic materials

short cut research steps to benefit farmers. However, the overall quality of the services was considered above average.

4.3.4 Assistance from non-CGIAR agencies

There was a relatively large number of researchers who marked "no contact" with various services from the non-CGIAR agencies. At the same time, the list of the agencies with the "most contact" was quite long. It could be that the assistance of these agencies has been small in financial terms, as shown in the research expenditure data, or restricted to certain research agencies only. However, the importance of this assistance was indicated in the favorable response from the researchers for workshops/conferences, training courses and newsletters.

4.3.5 Additional comments from the researchers

As with the administrators for research, researchers in the universities called for more interaction between the universities and the centers. The private sector would certainly also like to deal more directly with the centers.

5 Observations on Specific Issues

5.1 Linkages between NARS and IARCs

The evolution of the Thailand NARS, as presented in section 2, clearly identifies the significant supplementary role of the CGIAR in the process. Organizational changes in 1981 in the Department of Agriculture, MOAC, the main agency for crop research, was with the input from ISNAR.

IRRI has been collaborating with scientists in NARS since 1966 and has been providing genetic materials and training for Thai scientists, setting up workshops and conferences in which experts from all over the world can share experiences and circulating technical and research information. All these services have helped rice technology generation. Without this assistance, achievements in rice technology generation would never have been attained or would have taken a much longer time. The achievements have not been restricted only to impact on the NARS, but rice farmers have also benefited from 15 rice varieties from the famous R.D. series.

Corn is another outstanding example of collaboration. As with rice, the Rockefeller Foundation was the first to provide assistance, at a time when Thailand was putting much effort into improving corn production. The Rockefeller Foundation helped to establish the Corn and Sorghum Research Center in 1969 to coordinate research on corn between Kasetsart University and the Department of Agriculture. Genetic material was introduced from Guatemala, training was provided to the Thai scientists, workshops and conferences were held, and information on research and development of corn was circulated. All these services have improved research capacity particularly in the Kasetsart University and came, in part, from CIMMYT long before its regional office in Thailand was set up. Five varieties of corn

have been released resulting from the collaboration with the Rockefeller Foundation and CIMMYT.

In addition to the corn and sorghum program, CIMMYT also provided wheat genetic material in 1963 and a plant breeder and agricultural economist to assist the wheat research program. Crosses of CIMMYT's materials with the others consequently produced varieties which could be recommended.

The barley research program also collaborated with CIMMYT, which provided genetic material for crossing with local material, resulting in the release of Samoeng 1 and 2 varieties for farmers.

An organized cassava research program has not been operating very long in Thailand. Rayong 1 is the local variety being grown over most of the cassava area. In 1975, the seed of hybrid cassava was introduced from CIAT and in 1983, Rayong 2 and 3 were released.

Other centers in the CGIAR system have also played a supportive role to the NARS. Activities of the centers have been mainly concentrating on the enhancement of human capital for agricultural research through training and collaborative research with the centers' experts, broadening knowledge of researchers and coordinating research activities on a global basis through circulation of relevant information, and reducing the need for basic research through the provision of plant genetic materials.

5.2 Linkages between NARS and other donor agencies

Thailand has developed systems and mechanisms to coordinate foreign assistance for maximum utilization. A national economic and social development plan is being used to guide long-term development efforts. Development projects are submitted to NESDB to review for consistency with the National Development Plan

prior to the Cabinet's consideration. NESDB also formulates an annual plan to guide annual budget allocation. In addition, a 3-year rolling plan is used to regulate foreign assistance for maximum benefits to the country, since development priorities can change and readiness to implement some projects can cause postponement of the projects. In such cases reserve projects can be moved up from the reserve list. This is to ensure that the available resources can be utilized in a timely manner. With this system, Thailand has, to a great extent, been able to direct foreign assistance according to the national priorities.

Donor agencies have their own limitations and mandate in terms of policies and resources under their command and expertise available. It requires a collaborative effort to match the supply of the donor agencies with the national priorities and needs of the receiving countries. In the late 1960s, Thailand was emphasizing physical and human infrastructural development. During this period, USAID provided many services in institution building, resulting in the majority of Thai agricultural researchers receiving their graduate degrees from universities in the United States.

Even though there has been much effort to enhance human capital, overall the NARS still has many weaknesses. At the same time, agricultural policy shifted from extensive to intensive agriculture, and the greater reliance of the Thai economy on the world trading of agricultural commodities created demand for agricultural technology generation and diffusion. During the late 1970s, attention from the high authorities to agricultural research became more apparent.

Donor agencies also have a significant role to play in serving the national needs. The role of non-CGIAR agencies in Thailand has not been restricted to direct contributions only. Some have been coordinating among themselves, combining their specific types of expertise. The World Bank and the Asian

Development Bank have successful stories. There were weaknesses in the Thai NARS, as pointed out by several articles cited in detail in section 3 of this report. To improve it, many institutional issues needed to be tackled first. The World Bank has drawn upon the expertise of ISNAR and FAO in the national research organization to review the situation and to provide recommendations prior to the full effort of the World Bank to prepare a National Agricultural Research Project. In addition, the World Bank has also been able to bring additional financial assistance from IFAD, and the agricultural research experience of Australians, to support the overall attempt to improve the NARS of the country.

Apart from donor agencies involved in the NARS improvement mentioned, Thailand has enjoyed a host of other donor agencies as listed in section 4 of this report. However, it should be noted that few of them are specializing in agricultural research, as are the IARCs. Therefore, their assistance to Thailand has been mainly for rural and agricultural development rather than for pure agricultural research.

Collaboration between Thailand and donor agencies has gone through many changes. The key element is improvement on the Thai side. It must improve its own system and determine its own needs. This conclusion is drawn from past experiences in which Thailand accepted just about all assistance offered. Recently, Thailand has learned to reject assistance which is not in line with the national priorities, even though it comes in the form of a grant. Successful collaborative efforts have been the ones in which Thailand and donor agencies have the same objectives, activities are complementary, procedures and systems are Thai, and the conditions of the donors are not too restrictive to provide adequate flexibility for changes with changing economic and social situations.

Even though Thailand has shown much improvement in its NARS and its collaborative effort with various donor agencies, the mere number of research projects in various research institutes under various foreign assistance projects should be enough to cause concern about duplication of research activity. Many research projects deal with international agricultural commodities, but are not organized in such a way that they can be linked globally as are the commodities under CGIAR interest. This means that the scientists do not have access to a pool of germplasm which could expedite research results, and face difficulties in learning about similar activities by other researchers. Each individual country cannot perform these tasks by itself.

5.3 Impact of institutional and economic environment on adaptation of technology

Thailand is well endowed for agricultural production in terms of soils, water and climate. It is one of a handful of exporting countries with a significant comparative advantage in the production of a dozen crops. Between 1960 and 1980, agricultural output increased at 5 percent, or twice the population growth rate, through area expansion. During the same period agricultural land expanded at an average rate of over 4 percent per year. The rate of expansion was so high that land titling services fell behind, and in recent years only one-half of the total agricultural land has any official documents for occupancy. In addition, other serious problems loom on the horizon. Pockets of poverty still exist, mostly in rural areas. In the early 1980s, the annual growth of agricultural production slowed. Yields of major crops show a declining trend. Production of livestock and fish products has been virtually stagnant. Natural resource degradation has accelerated. Further, factors largely beyond the kingdom's control are threatening traditional export markets for agricultural commodities. Thai farmers now have to

compete with farmers in many developed countries in the world market.

The historical perspective of agriculture in Thailand clearly shows the absence of agricultural intensification through adoption of expensive technologies in the past, as farmers could expand their production through cheaper land expansion. But at present, Thailand's agricultural sector is at a crossroads. Land expansion in the early 1980s has only been at about 1.5 percent per year.

At present, most agricultural lands are well distributed and mostly owner-operated. About 20 percent of the total area has irrigation facilities for water control. There are pockets of soil problems such alkalinity and salinity prohibiting high rice yields, but they are small relative to the total land area. Farm input supplies are mainly handled by private traders. Farmers are keeping their own crop seed for planting. The use of pesticides is widespread and some are considered to be used in excess, leading to environmental and health problems. Hired services for land preparation are widespread, and the use of chemical fertilizers is optimal in irrigation areas but low in rainfed agriculture. Interest rate on credit to the agricultural sector is, by government policy, being kept at a ceiling of 13 percent, lower than the prevailing market rate. Overall marketing of farm inputs is competive now, even though in the past, the government policy to protect local infant industries was at the expense of the farm sector.

Thailand is, in many ways, attempting to develop a free and open society. The driving force behind this effort is efficiency of private enterprise in the development of more competitive prices in the international market and at home. Thailand has much experience in market intervention, resulting mostly in widespread negative effects. Many government agencies are still suffering financial losses from marketing farm outputs. To

manage a mixed, free and administered price system, with both domestic and foreign markets, is difficult. Therefore, the government has continued to move to free up the market, both domestic and foreign. However, it must be accepted that excessive price uncertainties and inconsistencies caused primarily by ad hoc government actions on a commodity by commodity basis, had and would continue to have adverse effects on agricultural technology adoption. But there are constraints which must be accepted, and technical people have to take them into account in their development of technologies.

The government has been aware of socioeconomic differences between farmers but not until the present National Development Plan have policy distinctions been made between commercial and subsistence sectors of agriculture. In the plan, the commercial sector is dependent on private initiative through mutual agreement between the farmers and the business sector. The subsistence sector looks largely to public investment to enhance its potential for increasing income and contributions to the economy. It is uncertain that agricultural researchers and extension officials have been able to fully conceptualize the distinction. Their responses in the interviews did not reflect such an understanding. Many of them still treat agriculture as a single set of conditions and situations.

It is firmly believed that difficulties in agricultural technology transfer have been mainly due to plentiful and cheap resources, the lack of appropriate technologies, and inefficiency in the extension system.

Examples of technology transfer all over the world show clearly that transfer has been fastest where human beings have to face hardship for their livelihood. Once it happens, technology development and transfer continue due to the desire of humans to improve their living standards. Thailand has never really had to face this situation. Agricultural lands are productive,

plentiful and cheap. It has been cheaper to increase production through land expansion, involving no cash investment, than to adopt expensive technologies. This is believed to be the principal reason impeding the adoption of technology.

There are several problems at the receiving end of technology transfer. Poverty and little cash available at the farm level prevent farmers from adopting expensive technology. The education level is generally low, mainly grade 4, presenting difficulties for understanding technology. Culture and tradition can be limiting factors in technology adoption. Southern rice farmers continue to harvest their rice with traditional tools. Even though the practice causes relatively high harvesting loss, they do not change it for religious reasons. Many northeast farmers continue to grow glutinous rice, with limited market access, because they are used to it. Because of poverty, low education and generally low standards of living, formation of farmers' organizations has been difficult. This situation also limits adoption of technologies. Fruit growers, tobacco growers and sugarcane growers have been able to form organizations. They are the ones for whom technology transfer has not presented difficulties.

There are problems at the giving end, which includes the public and private sectors. The private sector has been active and successful in technology transfer. Cassava production has greatly expanded because of the private sector's response to world market opportunities. On the public side, there are many government agencies at the ministerial and departmental levels, but there has been no unified extension plan. Each agency, even at the departmental level, tends to have its own plan in isolation from the others. Extension officials are not part of the farm enterprise and the government merit and reward system does not take into account losses or gains that farmers may experience from extension activities. Lack of real understanding of farmers is quite critical. Most extension officials at the

grassroot level are young and inexperienced. Modern facilities at their disposal, such as motorcycles, help to separate them even more from the farmers. Prior to the availability of good transportation, extension officials had to stay much longer with farmers because of the transportation inconveniences and had the chance to learn and know more about them.

Thailand has many scientists educated and trained in developed countries. The transfer of technologies from the outside world to Thailand should not face too serious constraints. But the ability to understand the needs and the decision making process of the farmes as a guide for research to select the appropriate technologies for specific localities does present a problem at present. The biological researchers are very isolated from the etension officers, economists and sociologists.

Finally, Thailand has made many improvements in its agricultural research and extension system. But there are a lot more improvements needed to be made. Clearly there is a need to shift from quantity to quality both in research and extension.

5.4 Spread and impact of innovations from CGIAR

Since the IARCs which have significant collaboration with Thailand are commodity-oriented, the impact is best looked at in terms of specific commodities.

Rice

Rice is by far the most important crop in Thailand in both rainfed and irrigated areas. Wet season rice predominates, since it is the only crop able to withstand the annual period of flooding. Rice is also relatively well adapted to the heavy clay soils of the central and northern regions. The total planted rice area grew steadily from 5.5 to 9.5 million ha over the last 20 years, and in recent years has tended to remain stable at this level. Only one-fourth of this area is irrigated.

The evolution of rice research in Thailand has been presented in section 2. Since the mid-1950s, the government's emphasis on rice research has led to the breeding of numerous improved local varieties which were particularly suited to different local conditions. These varieties are now widely grown, and have also provided the basis for hybridization with IRRI varieties to produce the "test accepted" semidwarf R.D. varieties, now used in 80 percent of the wet season irrigated areas with good water control, and 100 percent of the dry season rice.

Many references confirm the significant role of IRRI in rice technology development in Thailand. The impacts have been felt at the farm level through the R.D. varieties. R.D. 1 and 3 have been released since 1969. In the early 1970s, R.D. 2 was released. By the mid-1970s, R.D. 4, 5, 7 and 9 were released. By the early 1980s the series had reached R.D. 25. At present, R.D. 6, 8, 13, 15 and 19 are still recommended varieties. Recently in addition to the above varieties, R.D. 7 and 23 have shown signs of greater acceptance by farmers (Department of Agriculture, 1983).

Annual rice production stagnated in the 1960s around 10 to 11 million tons and then rose rapidly in the 1970s in response to the release of high-yielding varieties (HYVs) and improved water supply in various regions of the kingdom. R.D. 19, which is tolerant of water depth up to one meter, dominates the lowlands of the central region. R.D. 13 has shown good performance in the south under very humid conditions and R.D. 15 has shown some drought tolerance in the northeast.

R.D. varieties now dominate the irrigated rice area. In the 1982/83 crop year there were 17.5 million rai (2.8 million ha) of rainy season crops and 3.8 million rai (0.6 million ha) of dry season crops, producing 6.7 million tons and 2.3 million tons of paddy respectively. Overall, these accounted for about 29

percent of planted area and 54 percent of the total national production. The impact on yield of the HYVs was outstanding. Average yield of paddy in Thailand has been about 1.4 t/ha. Rainy season irrigated rice yields about 3.1 t/ha while the dry season irrigated rice on average yields 3.9 t/ha.

These impacts on planted area and production mean that the benefit has been felt at the farm level by more than 29 percent of total farm families. The numbers are on the conservative side, since R.D. varieties have now been extended outside of the irrigated area, particularly R.D. 15 in the rainfed area in the northeast, but no record of the total area covered could be obtained. Similarly, R.D. 13 in the south will contribute further to greater impact. In the past, the benefits tended to accrue to the better-off farmers in the irrigated area, but there has recently been a tendency to distribute benefits further into the rainfed farms on which less well-off farmers live. The benefits should not have any differential effect on men and women since family laborers are the main source of the labor force. Both men and women work in the field. A change in rice variety has not changed the labor requirement pattern from that of traditional varieties.

Corn

The evolution of corn research clearly shows the impact of CIMMYT, as presented in section 2. Suwan varieties are the product of genetic material obtained from CIMMYT. Virtually all corn planted is the result of crosses from CIMMYT material. The main benefit is resistance to downy mildew, which had been causing terrific yield reductions. The impact of CGIAR collaboration in corn research has been felt at the farm level since 1969, with the first releases of Phra Puthabaht 3. Suwan 1 was released in 1975 and No. 2301 in 1983. Thailand is producing about 2.8 million tons of corn from about 10.6 million rai (1.7 million ha) annually. The average yield between 1981 and 1983 is about 2.2 t/ha which is quite high when compared to other

countries in the region. The impact of the corn program at the farm level covers about 7 percent of total agricultural land on which about 300,000 farm families or 6 percent of the total, earn their living. Since corn growing areas are in the northeast and the north, where poverty is most concentrated, the benefits of the technology are expected to reach small farmers.

Cassava

The impact of CGIAR in cassava has not yet reached the farm level. Collaboration with CIAT is still new. The main variety grown is still the local variety.

Wheat

Wheat is a minor crop in Thailand. Even though improved varieties are available through collaborative research work with CIMMYT, adoption by farmers has not been significant. The planted area was only about 150 ha in 1983 with production of about 150 tons.

Barley

Barley is another minor crop. Improved varieties are available with assistance from CIMMYT. It is a crop facing demand constraint.

5.5 Potentially significant innovations and their expected impact

Improvement of R.D. 13, in terms of developing an acceptable taste for the southern part of the country, would help that area be self-sufficient in rice. This region has been identified as containing many pockets of poverty. The south has 39 percent of the national total rice area. The adoption by rice farmers in the south should contribute significantly to nutritional upgrading of the region and rice production of the country as a whole. No new technology is immediately expected for corn. For cassava, introduction of biotechnology to increase protein

content should have some impact on the local animal feed industry and will consequently help small farmers who produce cassava. For other crops, in the next few years, no definite technology improvements can be expected.

Appendix

Directors and Principal Scientists Interviewed

National Government Research Programs

1. Director-General, Department of Agriculture, MOAC.
2. Deputy Director-General, Department of Agriculture, MOAC.
3. Director, Upland Crops Research Institute, Department of Agriculture, MOAC.
4. Director, Rice Research Institute, Department of Agriculture, MOAC.
5. Eight principal scientists in Upland Crops Research Institute, MOAC.
6. Nine principal scientists in Rice Research Institute, Department of Agriculture, MOAC.
7. Director, Special Project Division, Department of Livestock, MOAC.
8. Director, Ruminant Animal Project, Department of Livestock, MOAC.

Universities and Research Institutions

1. Dean of Agricultural Faculty, Kasetsart University.
2. Dean of Agricultural Faculty, Khon Kaen University.
3. Two principal officers, Chiang Mai University.
4. One principal officer, Songkla University.

Private Sector Firms

1. Marketing Manager, Cargill Seed Ltd.
2. Varietal Improvement Manager, Charoen Seeds Co. Ltd.

Planning Office

1. Deputy Secretary-General, Office of Agricultural Economics, MOAC.
2. Director, Agricultural Planning Sector, NESDB.

National Extension Program

1. Director, Project Division, Department of Agricultural Extension.
2. Director, Crops Promotion Division, Department of Agricultural Extension.

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