REPORT ON THE EXPERIMENTS, RESEARCH, AND RESULTS OF THE SURVEY FOR THE JOINT DEVELOPMENT OF THAI SOYBEANS

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COLOMBO PLAN JAPANESE EXPERTS
ON SOYBEAN PROJECT

DEPARTMENT OF AGRICULTURE
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OVERSEAS TECHNICAL COOPERATION AGENCY, TOKYO JAPAN

CONTENT

Introduction

One of the important objectives of the Thai Government is to attain a certain level of industrialization. In 1960, the Government started to revise the Industrial Promotion Law and in 1962, this Law became known as the Industrial Investment Promotion Law. At the present time, Thailand is in the 3rd stage of the Economic Development Plan, which started in October 1971, and places emphasis on the promotion of exports. In order to achieve this goal, it is imperative to reduce the income gap (between the high and low brackets) and to increase agricultural productivity.

Of the state area of 514,000 square kilometers representing Thailand, 23% is under cultivation, 52% is forests, and the remaining 25% is grassland and others. Table 1 shows the yield of the major agricultural products during the last ten years. It can be seen that the increase in production of maize is quite marked; that is, comparing the yield of 1959 to that of 1968, the increase registered 5.4 times. Table 2 shows the remarkable increase of export volume.

With regard to the assistance by Japan to develop the primary products of Thailand, an investigation team was dispatched to Thailand to survey the actual conditions for 2 months beginning in February of 1968. The objectives of this initial survey were to confirm the basic policies in the development of the primary products and to find any obstacles that might arise. Following this initial mission, an investigation team arrived in January of 1969 to investigate the actual situation and to carry out experiments in order to grasp the truth concerning soybean cultivation in Thailand.

As a result of this investigation, technical assistance was dispatched in the form of experts in the fields of breeding, cultivating, and marketing (1 in each field) in April and May of 1970. These 3 experts were scheduled to stay in Thailand for 2 years carrying out research in their respective fields with the aim of solving the problems involved.

Table 3 shows the present situation of soybean cultivation in Thailand. Sukothai province, the center for soybean cultivation in the rainy season (in

the Central Plains), has approximately 289,000 rais of soybean growing area, and Chiang Mai Province, the center for soybean cultivation in the dry season (in the Northern Region), has approximately 33,000 rais. In planning for an increase in production, the goal was set at an increase from 50,000 tons per annum at the present time to 300,000 tons per annum in five years time. In order to achieve this goal, it is necessary to increase production in various areas, such as in the Central Highland; by second cropping in the rainy season - that is, to plant soybeans after the maize crop; in Chinat Province in the Central Plains, the center for soybean cultivation in the dry season, after the rice crop; in the North Eastern area by planting soybeans in the rainy season; in the areas growing kenaf at present and growing soybeans in the dry season, after the rice crop.

Sukothai Province in the Central Plains, the center for soybean cultivation in the rainy season, and Chiang Mai Province in the North, the center of soybean cultivation in the dry season, are two areas where soybeans have been grown extensively for a long time. Therefore the Japanese experts concentrated their research and experiments in this area first for considering the problems involved in increase of productivity.

From the results of the investigation to be mentioned later, and from the solution of each problems to be shown, it can be said that it will be possible to increase production per unit area of cultivation in these regions which will in turn increase total productivity.

In the Central Highland region in Saraburi Province, the center for maize cultivation, maize is grown once in the rainy season. Continuous cultivation of maize will gradually decrease the fertility of the soil, thus decreasing productivity of maize per unit of cultivated area. This will become a major problem in the future if the situation is left as it is. As a countermeasure, the introduction of chemical fertilizers was considered, but maize itself has a high capacity to absorb the fertilizer so that the supply of a small amount of fertilizer to maize will not be useful in maintaining the soil fertilizer. The productivity of the soil will continue to derease. Should a large amount of fertilizers be introduced, economic problems will airse;

i.e., the price of maize will not be high enough to cover the production cost.

One way to solve this problem is the introductionoof crop rotation, which will maintain and increase soild productivity. At the present time, after the maize, which is planted in May, is reaped in August, mung beans is grown. It is felt that the cultivation of beans after the maize crop is one method to help to prevent soil deterioration. Therefore, in this case, it is planned to introduce soybeans as a second crop, after the reaping of corn. This is one method to increase the yield of soybeans and of maize at the same time.

At the present time, most of the farmers in the cornbelt use tractors (on hire, about 5,000) to plow the land and in the shelling process. The cultivation of maize also benefits from mechanization. Cultivation of soybeans also by the introduction of mechanization machines saves much labour and can enlarge the area of cultivation which in turns increases the yield. However, it is important to do further research so as to establish a cultivating system appropriate to the introduction of mechanical power.

In the North East when the fields are used for planting in the rainy season, kenaf has been recommended. Recently, however, thedemand for kenaf has been limited due to competition from synthetic fibres. It only requires a small change in the balance of supply to result in a large variation in kenaf prices. Furthermore, planters in this area who are already poor will have to face difficult situations. The soil in the North Eastern region is mainly a fine sandy type (Korat sandy loam), originating from sandstone, thus resulting in low soil productivity. If the soil conditions are not improved, there will be no hope of increasing the yield.

Other plants such as sorghum and soybeans have been considered as substitutes for kenaf in this area. This countermeasure has an aim similar to the one applied in the Central Highland. By changing from kenaf to soybean, soil productivity and the yield of soybeans will be increased. In this case, however, nodule bacteria which are important to the growth of soybean are lacking in most areas, creating a big problem in soybean production.

Therefore, the countermeasure should be studied thoroughly.

Dry season planting of soybeans in the North East is also similar to that in the North since irrigation facilities are the prime requirement. It has been estimated that irrigated areas in the North East will amount to approximately 380,876 Hectares, but only 206,120 Hectares (Table 4) have adequate irrigation facilities. At present irrigation facilities are being built which, when completed, will enable planting to be carried out in the dry season. At this stage, however, planting of soybeans in the rainy reason still merits first priority.

Planting of soybeans in the dry season following rice crop is carried out mostly in the Central Plains of Chainat Province due to the fact that the area is fully irrigated and the soil is fertile. If the process is aided by machines, the area would have a bright prospect of becoming a center of soybean planting. Nevertheless, the farmers require strong financial support from the Government so as to be able to acquire farm machineries. In addition the machines must be efficiently used according to a carefully developed plan.

Because the soil in this area is very compact and has poor permeability which often causes the root rot of plants, land improvements with good irrigation and drainage facilities are indispensable for soybean cultivation.

As shown in Table 3, soybean cultivation in Thailand is carried out mostly in the rainy season. Problems related to each region will be reported later in the Chapter on the survey of the Actual Conditions of Soybean Cultivation.

Tables 4-7 show the environmental factors in each soybean cultivation area; these are temperature, humidity and amount of rainfall. The day-length in Bangkok and Chiang Mai Provinces are shown in Table 8. It is evident that these factors vary markedly from place to place, leading to problems of finding suitable varieties of seeds and different practical methods applicable to each planting area. Research results obtained from each experiment station would help to determine the correct methods of cultivation and propagation.

The Japanese breeding and cultivation experts on soybeans first started their experiments at the Mae Jo Agriculture Experiment Station in the North because the station is fully equipped and well staffed compared to other stations. (There are 19 Experiment Stations and 11 Seed Multiplication Stations in Thailand.) They later performed experiments at the Kalasin Seed Multiplication Station, Kalasin Huey Srithon Pilot Farm, Srisamrong, Prabudhabath, and at Roi-et. They also worked together with the marketing experts who carried out the study by interviewing people in the major soybean growing areas and the supply depots to gather production and marketing information. The results of the experiment and the survey will be discussed later.

The technical cooperation has also helped to improve the quality of the research staff, particularly those who worked on the project at the Mae Jo Experiment Station.

However, it should be noted that the observation period of soybean growth requires close attention by the researcher to enable him to correctly interpret the results and to draw the correct conclusions from them.

It is believed that the training has produced researchers of a higher calibre. However a large-scale research for the purpose of developing soybeans cultivation methods with immediate results requires a large number of well-trained research technicians in different specilized fields. Steps should therefore be taken in this direction.

At the same time in order to publicize the newly discovered techniques of growing soybeans, the extension officer himself must understand the techniques thoroughly and the farmers should also to be trained. Furthermore, an extension officer should be sent to the propagation station in the major soybean cultivation areas to give advice and to see to it that his suggestions are put into practice correctly and effectively.

It should be kept in mind that once a new technique fails, for what ever reasons, they will never be used again. In short, both the

researcher and the extention officer would have to continually observe the techniques as applied in actual practice so that they can detect problems and give correct advice to the farmers.

The following is the report on the results obtained by the Japanese experts in breeding, cultivation and marketing of soybeans during the past two years, each section being discussed separately. It is hoped that the information will help in the future development of Thai soybeans.

A number of persons have shown great interest in this research; namely, Mr. Tatsuke, Director General of Overseas Technical Cooperation Agency; Mr. Matsubara, Chief of Primary Products Development Cooperation Office; the officers concerned in the Ministry of Foreign Affairs, Ministry of International Trade and Industry and Ministry of Agriculture and Forestry; His Excellency Masato Fujisaki, the Ambassador of Japan, and the Embassy officials; Mr. Moriya Miyamoto, Chief of the OCTA office in Bangkok, and the officers concerned; Dr. Jisuke Takahashi and Dr. Hidetoshi Matsuo, FAO officers in Bangkok.

The experts received close cooperation from Dr. Phit Panyalaksana, Director of Department of Agriculture, Ministry of Agriculture; Mr. Samai Chareonrath, Assistant Director; Mr. Tomya Bunyaketu, Chief of Research Division; and also from Dr. Arwooth Na Lampang and Mr. Amnuey Tongdee who were the counterparts. Without their help this research would not have been possible.

Also at the Agriculture Experiment Station and Seed Multiplication Station where cultivation and breeding experiments were carried out, assistance was received from Mr. Sunun La-ongsri, Chief of Mae Jo Agriculture Experiment Station; Mr. Kasem Sukhaphan, Chief of Kalasin Seed Multiplication Station; Mr. Supachai Nilaphan, Chief of Roi-et Agriculture Experiment Station; and Mr. Tawee Euprasert, Chief of Srisamrong Agriculture Experiment Station.

In carrying out the survey and interviews, the experts received close cooperation from Dr. Tamnong Singkalavanich, Director of the Department

of Extension, Ministry of Agriculture; Mr. Prasert Penchitr, Assistant Director; Mr. Petcharat Vanapee and the officials concerned. In addition, direct cooperation was given by Mr. Savasdi Yuvajita who also acted as interpreter and whose help is gratefully acknowledged.

Finally, the experts also received constant assistance from Mr. Chote Suvipakit of the Department of Agriculture, Ministry of Agriculture, to whom we cannot even find adequate words to express our gratitude. We would therefore like to take this opportunity to express our gratitude to all these persons whose names have been mentioned.

Cultivation Expert: Hisashi Yarimizu
Breeding Expert: Takashi Sanbuichi
Marketing Expert: Haruhiko Seto

Table 1. Yield of Major Agricultural Products of Thailand

(unit: thousand ton)

Item/Year	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
rice	7,053.2	6,769.8	7,834.5	8,176.6	9,279.5	10,028.9	9,558.2	9,217.9	11,845.5	9,594.8
rubber	161.0	171.8	186.1	195.4	198.3	210.6	217.4	218.0	220.0	229.0
maize	317.2	543.9	598.3	665.4	857.7	935.1	1,021.3	1,122.0	1,250.0	1,330.0
cassava	1,083.0	1,222.0	1,726.0	2,077.0	2,111.0	1,557.0	1,475.0	1,891.7	1,871.0	2,000.0
sugarchane	4,988.0	5,382.0	3,984.0	3,154.0	4,733.0	5,074.2	4,480.0	3,827.0	3,500.0	3,500.0
coconut	905.0	1,040.0	1,054.0	1,098.0	1,147.0	1,097.0	1,170.0	1,069.0	1,000.0	1,250.0
cotton	37.0	43.0	32.8	43.6	52.9	39.0	31.6	41.9	45.5	40.0
kenaf	50.0	181.3	239.0	134.0	211.7	303.1	528.6	661.4	350.0	174.0
tobacco	67.1	74.1	48.4	47.9	46.6	62.8	75.5	88.4	80.0	90.0

(Agricultural Statistics of Thailand Department of Agricultural & Rice Department, Ministry of Agriculture)

Table 2. Export of Thai Maize

(Unit: ton)

Year (August-July)	Total production in Thailand	Export	Export to Japan.	Ratio of Total Export to Japan
1957	136,800	64,337	47,524	73.87 %
1958	186,300	162,914	109,501	67.21
1959	250,000	236,000	191,530	81.16
1960	543,900	521,592	446,295	82.05
1961	598,300	599,098	391,764	65.39
1962	750,000	725,403	427,803	58 97
1963	950,000	926,864	578,961	62.46
1964	935,125	862,490	686,420	79.59
1965	1,021,300	1,130,277	755,269	66.82
1966	1,021,000	1,158,422	760,933	65.69
1967	1,250,000	1,191,707	617,440	49.40
1968	1,350,000	1,244,421	431,307	34.66

(Source: Japanese Feed Export - Import Council)

Table 3. Soybean Plantation in 1968

Zone	Planted area Rai	Damaged area Rai	Harvested area Rai	Production Kg.	Average yield Kg. per Rai
Total	328,980	40,884	288,096	44,784,774	155
Central Plain	288,890	39,473	249,417	38,783,990	155
Northern	32,792	442	32,350	5,320,095	164
North Eastern	7,056	964	6,092	644,362	101
Southern	242	5	237	36,327	153
Total Central Plain	288,890	39,473	249,417	38,783,990	155
Kanchanaburi	260	120	140	400	60
Kampaeng Phet	8,140	5	8,135	1,220,250	150
Chachoengsao	6,500	-	6,500	1,170,000	180
Chainat	2,947	-	2,947	442,050	150
Tak	6,071	200	5,871	1,056,780	180
Nakhon Nayok	30	30	-	-	-
Nakhon Pathom	61	-	61	12,200	200
Nakhon Sawan	24,799	919	23,880	4,680,480	196
Pachuap Khiri Khan	370	-	370	44,400	120
Prachin Buri	246	-	246	25,338	103
Ayutthaya	256	19	237	37,920	160
Phichit	785	-	785	117,750	150
Phitsanulok	1,072	104	968	125,840	130

Zone	Planted area Rai	Damaged area Rai	Harvested area Rai	Production Kg.	Average yield Kg. per Rai
Phetchaburi	500	10	490	117,110	239
Phetchabun	2,000	300	1,700	170,000	100
Rayong	-	-	-	-	-
Ratchaburi	2,488	360	2,128	425,600	200
Lop Buri	213	-	213	31,950	150
Saraburi	4,882	1,108	3,774	509,493	135
Sing Buri	1,139	-	1,139	148,070	130
Sukhothai	224,803	36,250	188,553	28,282,950	150
Suphan Buri	528	23	505	55,550	110
Ang Thong	423	25	398	43,780	110
Uttaradit	170	-	170	31,790	187
Uthai Thani	207	-	207	26,289	127
Total Northern	32,792	442	32,550	5,320,095	164
Chieng Rai	3,475	299	3,176	574,856	181
Chieng Mai	14,850	-	14,850	2,613,600	176
Nan	5,599	20	5,579	730,849	131
Phrae	2,400	-	2,400	240,000	100
Mae Hong Son	3,500	-	3,500	630,000	180
Lampang	2,078	123	1,955	351,900	180
Lamphun	890	-	890	178,890	201

Zone	Planted area Rai	Damaged area Rai	Harvested area Rai	Production Kg.	Average yield Kg. per Rai
Total North Eastern	7,056	964	6,092	644,362	101
Khon Kaen	432	32	400	38,800	97
Chaiyaphum	127	-	127	27,559	217
Nakhon Phanom	145	15	130	7,800	60
Nakhon Ratchasima	5,397	890	4,507	455,207	101
Maha Sarakham	6	-	6	1,056	176
Roi-Et	211	-	211	25,320	120
Loei	33	3	30	4,200	140
Surin	277	-	277	33,240	120
Nong Khai	3	-	3	390	130
Udon Thani	318	6	312	37,440	120
Ubon Ratchathani	107	18	89	13,350	150
Total Southern	242	5	237	36,327	153
Chumphon	51	-	51	8,925	175
Nakhon Sithammarat	33	-	33	5,808	176
Phangnga	13	-	13	780	60
Songkhla	38	5	33	9,900	300
Surat Thani	107	-	107	10,914	102

Note: 1 rai = 16a

Table 4. Irrigation Planning and Irrigation Area

Zone	Capacity Mill. M^3	Irrigable area in Hectares	Irrigated area in Hectares
Total for North and Upper Central Regions	24,047.78	395,456	310,032
Total for Central East and West Regions	1,701.22	1,909,560	1,435,880
Total for Northeast Regions	3,282.33	380,876	206,120
Total for South Regions	0.78	219,840	80,432
Grand Total	29,032.11	2,905,732	2,032,464

(Source: Royal Irrigation Department)
June 1971

Table 5. Temperature in Each Region (average from 1951 - 1965)

1) Chiengmai

Temperature (°C)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
Mean	21.0	23.1	26.0	28.8	28.9	27.8	27.4	27.0	26.9	26.1	24.3	21.5	25.7
Mean Max.	29.0	32.0	34.9	36.5	34.7	32.1	31.5	30.8	30.8	30.6	30.0	28.5	31.8
Mean Min.	13.3	14.0	16.9	21.0	23.3	23.5	23.3	23.2	22.9	21.6	18.6	14.5	19.7

2) Khonkaen

Temperature (°C)													
Mean	22.8	25.7	28.6	30.3	29.8	28.8	27.0	28.1	27.7	26.6	25.2	22.8	27.0
Mean Max.	30.5	32.9	35.5	36.9	35.0	33.1	32.7	32.2	31.6	31.5	31.1	30.1	32.8
Mean Min.	15.2	18.5	21.5	24.0	24.5	24.5	24.0	24.0	23.6	22.2	19.2	15.6	21.4

3) Roiet

Temperature (°C)													
Mean	22.7	25.7	28.2	30.0	29.7	28.7	28.2	27.9	27.6	26.7	25.0	23.0	27.0
Mean Max.	29.9	32.2	34.6	35.9	34.6	32.8	32.2	21.6	31.0	31.0	30.7	39.7	32.2
Mean Min.	15.9	18.9	21.8	24.2	24.8	24.6	24.3	24.3	24.1	22.4	14.4	16.4	21.3

4) Nakhonsawan

Temperature (°C)													
Mean	24.6	27.6	30.0	31.5	30.6	29.4	28.8	28.5	28.0	27.7	26.3	24.2	28.1
Mean Max.	32.0	34.4	36.7	37.9	36.3	34.2	33.6	33.0	32.2	31.7	31.5	30.8	33.7
Mean Min.	17.1	20.8	23.4	25.1	25.0	24.5	22.4	24.0	24.1	23.5	21.2	17.6	22.4

5) Lopburi

Temperature (°C)													
Mean	25.5	28.3	30.0	31.0	30.1	28.9	28.3	28.1	27.7	27.4	26.4	25.3	28.1
Mean Max.	32.6	34.7	36.3	37.2	35.4	33.5	32.6	32.3	31.6	31.5	31.5	31.7	33.4
Mean Min.	18.5	21.9	23.8	24.9	24.8	24.2	24.5	24.0	23.8	23.7	21.2	18.8	22.8

6) Kanchanaburi

Temperature (°C)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
Mean	24.6	27.5	29.9	31.3	30.2	28.9	28.4	28.3	27.9	27.1	25.8	24.1	27.8
Mean Max.	32.3	34.8	36.6	38.0	22.7	33.5	32.9	32.7	32.3	31.0	31.0	30.8	32.4
Mean Min.	16.8	20.2	22.7	24.6	24.8	24.4	23.9	23.9	23.6	22.9	20.6	17.5	22.0

7) Bangkhen

Temperature (°C)													
Mean	25.6	27.4	28.8	30.0	29.7	29.0	28.6	28.4	28.0	27.8	26.9	25.5	28.0
Mean Max.	32.2	33.3	34.4	35.6	34.7	33.3	32.7	32.5	31.9	31.5	31.1	31.1	32.9
Mean Min.	19.0	21.4	23.1	24.5	24.7	24.6	24.4	24.4	24.3	24.1	22.8	19.8	23.1

8) Songkhla

Temperature (°C)													
Mean	26.7	27.1	27.5	28.4	28.7	28.4	28.1	28.1	27.9	27.3	26.7	26.5	27.6
Mean Max.	29.4	30.1	31.3	32.6	33.0	32.8	32.6	32.6	32.2	31.1	29.7	29.2	31.4
Mean Min.	23.9	24.0	23.8	24.1	24.4	23.9	23.5	23.6	23.5	23.5	23.6	24.8	23.9

9) Phyket

Temperature (°C)													
Mean	27.3	28.0	28.6	28.8	28.1	27.8	27.4	27.5	27.1	27.2	27.1	27.2	27.7
Mean Max.	31.3	32.5	33.0	33.0	31.7	31.2	30.8	30.7	30.2	30.5	30.5	30.8	31.4
Mean Min.	23.3	23.6	24.1	24.6	24.5	24.5	24.1	24.2	23.9	23.8	23.7	23.6	24.0

Table 6. Humidity in Each Region (average from 1951 - 1965)

1) Chiengmai

Relative Humidity (%)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
Mean	75.1	67.0	59.0	59.4	72.1	79.7	81.0	84.0	84.3	81.8	80.6	78.1	75.2
Mean Max.	95.6	92.2	85.3	77.8	89.9	93.5	93.9	94.7	95.5	95.7	95.8	95.9	92.2
Mean Min.	42.8	34.2	30.0	33.6	50.5	61.5	63.4	67.3	66.5	62.3	54.9	49.1	51.3

2) Khonkaen

Relative Humidity (%)													
Mean	63.8	62.9	62.0	63.1	72.5	75.9	77.8	79.9	81.5	77.2	70.6	66.7	71.2
Mean Max.	87.6	85.4	84.0	83.1	88.2	88.9	90.4	91.7	92.8	91.1	88.6	88.9	88.4
Mean Min.	45.0	44.4	43.8	45.3	56.3	62.6	64.6	66.4	68.2	62.6	52.4	47.4	54.9

3) Roiet

Relative Humidity (%)													
Mean	65.8	63.1	61.7	64.0	73.5	77.0	76.7	80.8	82.4	77.6	72.9	68.4	72.0
Mean Max.	87.9	85.3	82.5	83.0	89.1	91.3	91.5	92.6	93.4	91.1	90.7	89.4	89.0
Mean Min.	44.9	43.8	43.5	45.7	56.2	62.4	63.9	67.5	69.3	63.3	53.7	49.0	55.3

4) Nakhonsawan

Relative Humidity (%)													
Mean	64.7	63.4	62.3	62.5	69.8	74.4	76.4	80.7	82.2	80.2	74.4	68.4	71.6
Mean Max.	89.3	87.9	88.5	87.7	89.6	90.9	92.3	93.6	95.3	94.9	93.7	91.6	91.3
Mean Min.	40.9	42.9	41.6	42.5	51.6	58.6	60.8	64.1	67.5	65.4	56.7	47.9	53.4

5) Lopburi

Relative Humidity (%)													
Mean	58.7	62.8	65.0	66.4	74.0	76.7	78.8	80.5	83.2	79.1	71.8	62.4	71.6
Mean Max.	78.7	83.8	86.0	86.7	90.7	92.0	92.9	93.4	94.7	91.3	86.8	90.7	88.2
Mean Min.	39.6	41.5	44.3	42.6	53.3	58.7	61.8	64.1	68.1	64.4	55.4	44.8	53.2

6) Kanchanaburi

Relative Humidity (%)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
Mean	62.4	60.8	57.4	58.6	70.0	72.9	73.5	74.3	77.8	79.7	74.5	67.0	69.1
Mean Max.	88.2	86.5	83.3	81.8	88.2	88.5	88.6	89.8	91.9	93.2	92.1	90.3	88.5
Mean Min.	42.7	52.1	38.0	39.7	53.4	59.2	59.3	60.0	63.3	66.2	60.4	50.8	54.7

7) Bangkhen

Relative Humidity (%)													
Mean	64.3	67.4	67.5	67.5	71.5	72.9	74.5	75.5	78.4	78.9	75.3	67.9	71.8
Mean Max.	92.5	93.5	93.4	90.9	90.8	89.7	89.9	90.4	72.0	92.0	91.4	91.6	91.5
Mean Min.	46.2	53.4	50.8	51.2	57.2	60.6	62.5	64.3	67.8	68.7	62.9	52.0	58.1

8) Songkhla

Relative Humidity (%)													
Mean	77.8	77.3	77.4	77.9	80.2	79.0	79.5	79.0	80.5	83.9	85.0	82.0	80.0
Mean Max.	87.3	87.6	90.5	92.3	99.2	92.2	92.5	92.3	92.9	92.8	94.1	91.4	92.3
Mean Min.	69.5	67.3	61.2	63.7	63.6	61.9	62.2	26.1	63.0	68.6	73.6	73.3	65.8

9) Phuket

Relative Humidity (%)													
Mean	73.3	72.1	72.9	76.1	82.0	80.3	81.0	81.3	83.5	83.7	80.9	76.2	78.6
Mean Max.	89.0	89.5	91.1	93.1	94.4	92.6	93.1	92.7	94.2	94.8	93.3	91.2	92.4
Mean Min.	58.5	55.9	56.9	62.9	68.6	68.2	69.0	68.8	70.6	60.2	67.6	62.9	65.0

Table 7. Rainfall in Each Region (1951 - 1965 year average)

1) Chiengmai

Rainfall (mm.)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
Mean	11.8	11.0	18.7	51.4	156.9	154.9	175.4	218.6	276.5	153.6	31.9	17.9	1278.6
Mean rainy days	1.6	1.2	2.2	5.1	14.6	17.8	20.2	23.5	18.9	11.9	4.4	1.8	123.2
Greatest in 24 hours	33.7	47.7	68.1	78.0	73.2	96.3	60.0	85.4	118.4	144.9	61.6	75.0	144.9

2) Khonkaen

Rainfall (mm.)

Mean	7.7	16.1	43.1	62.7	176.1	165.4	147.4	178.6	286.9	104.4	10.3	0.3	1193.0
Mean rainy days	1.1	2.6	4.8	6.5	14.1	14.1	16.1	18.0	18.4	10.9	1.6	0.1	108.3
Greatest in 24 hours	31.6	47.8	70.2	65.7	96.9	112.3	92.8	99.0	141.6	69.4	55.9	3.5	141.6

3) Roiet

Rainfall (mm.)

Mean	1.8	10.0	33.4	81.6	178.2	181.5	208.6	256.8	331.8	103.6	7.5	0.2	1395.0
Mean rainy days	0.7	2.1	4.1	7.1	14.3	13.9	15.3	17.8	19.3	8.8	2.0	0.3	105.7
Greatest in 24 hours	9.2	28.8	63.0	88.5	87.0	140.6	135.0	140.2	230.6	63.4	33.0	1.2	230.6

4) Nakhonsawan

Rainfall (mm.)

Mean	7.06	28.7	43.7	70.2	138.2	122.9	153.3	163.9	279.4	151.6	23.6	2.3	1184.8
Mean rainy days	0.9	1.7	2.9	4.8	11.1	13.8	14.4	16.5	18.3	11.5	2.5	0.5	98.9
Greatest in 24 hours	28.6	69.6	48.4	75.1	73.6	61.8	78.0	90.3	121.2	147.0	59.7	12.8	147.0

5) Lopburi

Rainfall (mm.)

Mean	1.7	18.9	68.8	76.8	172.7	150.4	185.2	168.0	289.1	192.4	43.6	3.3	1370.9
Mean rainy days	0.7	2.2	3.6	6.1	13.1	14.0	16.7	17.5	19.0	13.2	4.4	0.8	111.3
Greatest in 24 hours	8.0	41.4	117.1	104.6	113.6	85.5	99.4	74.9	105.1	165.0	96.5	17.0	165.0

6) Kanchanaburi

Rainfall (mm.)

Mean	3.4	17.3	33.1	64.3	149.9	85.0	113.7	102.8	239.1	244.6	54.0	2.6	1109.8
Mean rainy days	1.2	1.9	3.9	5.7	13.9	13.6	16.0	16.9	18.9	15.6	5.3	1.3	113.7
Greatest in 24 hours	16.4	43.9	45.8	72.1	95.4	70.8	64.7	73.9	78.9	143.5	72.5	5.0	143.5

7) Bangkhen

Rainfall (mm.)

Mean	4.7	31.0	34.3	65.4	155.7	166.9	172.6	228.9	334.8	297.7	42.9	3.9	1538.8
Mean rainy days	0.9	2.7	3.5	6.2	14.2	16.1	18.3	19.9	22.3	17.2	5.3	4.9	131.5
Greatest in 24 hours	15.6	63.5	42.8	64.7	108.1	144.3	69.9	103.9	125.2	140.3	51.4	29.6	144.3

8) Songkhla

Rainfall (mm.)

Mean	121.1	41.7	37.5	59.6	127.5	88.5	122.7	117.7	125.6	291.9	494.5	414.9	2043.2
Mean rainy days	12.5	5.7	5.4	7.4	13.9	11.1	12.4	13.7	15.1	21.3	22.4	20.2	161.1
Greatest in 24 hours	159.2	62.2	128.6	64.8	71.7	51.1	80.5	82.0	91.4	210.4	211.8	206.6	211.8

9) Phuket

Rainfall (mm.)

Mean	39.7	55.3	48.9	130.7	302.1	242.5	275.1	271.4	363.1	329.3	204.1	60.4	2292.6
Mean rainy days	5.0	3.5	5.4	12.7	21.8	17.6	19.6	19.8	22.1	22.5	16.1	9.0	175.1
Greatest in 24 hours	77.9	47.8	68.2	88.2	98.0	129.2	132.7	127.5	168.0	104.0	126.9	40.0	168.0

Table 8. Temperature, Humidity, Rainfall at Mae Jo Agriculture Experiment Station (year 1970, 1971)

Month		Air Temperature (°C)			Humidity (%)			Rainfall (mm.)
		Maximum	Minimum	Average	Maximum	Minimum	Average	
1970								
Jan.	1	29.2	13.7	21.5	99	34	66	2.4
	2	28.6	13.8	21.4	98	40	69	0
	3	29.5	11.4	20.5	98	32	65	0
	1	30.6	12.1	21.3	98	30	65	0
	2	31.9	12.8	22.3	95	28	62	0
	3	33.7	13.7	23.8	96	27	62	0
Mar.	1	35.7	14.1	25.0	95	25	60	0
	2	35.8	15.2	3.5	96	27	62	0
	3	33.1	15.2	24.5	94	34	65	47.8
Apr.	1	33.4	18.8	26.1	96	42	69	1.2
	2	34.2	19.6	27.0	96	37	67	15.4
	3	34.3	19.2	27.7	97	45	72	56.6
May	1	34.1	21.4	27.7	97	43	70	34.5
	2	32.6	22.4	26.9	96	55	75	259.8
	3	31.0	21.2	26.1	97	60	78	80.3
June	1	32.4	21.8	27.1	96	54	76	40.6
	2	31.3	22.1	26.7	96	62	79	28.3
	3	31.5	22.0	26.8	96	59	76	75.7
July	1	31.6	22.2	26.9	96	61	79	29.3
	2	29.9	26.6	25.7	96	68	82	52.2
	3	30.1	21.5	25.9	95	65	80	139.4
Aug.	1	29.6	23.1	26.4	96	8	82	53.2
	2	30.2	23.6	26.9	94	66	80	161.8
	3	30.0	23.4	26.7	95	69	82	75.5
Sep.	1	31.7	23.2	27.5	93	58	76	45.4
	2	30.8	23.6	27.2	93	66	80	162.6
	3	31.6	22.5	26.1	94	63	79	48.0
Oct.	1	30.9	21.2	26.1	90	53	72	9.8
	2	31.2	21.9	26.5	92	50	71	18.1
	3	29.9	21.2	25.3	92	60	76	22.3
Nov.	1	28.5	19.1	23.8	91	51	71	2.6
	2	30.7	19.4	25.0	94	47	71	0
	3	29.4	18.7	24.1	96	50	72	9.0
Dec.	1	27.4	20.3	23.9	96	67	82	22.9
	2	28.2	16.9	22.5	97	46	72	36.3
	3	29.2	14.8	22.2	97	38	68	0

Month		Air Temperature (°C)			Humidity (%)			Rain (mm)
		Maximum	Minimum	Average	Maximum	Minimum	Average	
1971								
Jan.	1	25.6	10.6	17.9	97	33	65	0
	2	28.4	12.0	20.2	97	35	66	0
	3	29.7	15.3	22.5	96	38	67	1.1
Feb.	1	28.8	14.4	21.7	97	36	67	0
	2	30.2	13.1	21.7	93	27	60	0
	3	32.5	15.2	23.9	91	31	61	0
Mar.	1	32.8	18.4	25.7	94	36	65	1.9
	2	34.0	18.3	26.2	93	34	64	T
	3	30.3	19.3	25.1	95	46	71	13.8
Apr.	1	34.3	18.3	26.4	86	26	56	0.2
	2	34.7	19.9	25.3	86	27	57	22.0
	3	34.6	21.3	28.0	89	32	61	6.0
May	1	33.6	22.1	26.9	88	41	65	61.3
	2	34.2	22.6	28.4	90	42	66	25.0
	3	31.4	22.8	26.8	96	51	75	262.8
June	1	30.3	23.4	26.9	94	63	79	77.6
	2	32.2	22.9	27.5	95	48	72	T
	3	31.0	23.3	27.2	95	57	77	91.6
July	1	30.1	23.0	26.8	95	58	77	49.6
	2	39.5	22.9	26.3	95	65	80	235.4
	3	29.3	23.1	26.2	95	64	79	57.5
Aug.	1	29.1	23.2	26.2	95	64	80	42.5
	2	29.5	22.9	26.2	94	63	79	116.9
	3	29.4	22.5	24.2	97	60	79	135.5
Sep.	1	28.6	22.9	26.3	97	64	81	31.5
	2	31.3	23.1	27.2	98	58	78	26.2
	3	31.3	22.3	26.8	97	53	74	93.5
Oct.	1	30.2	22.0	26.1	97	56	77	65.6
	2	29.5	18.4	24.0	95	56	71	0.6
	3	27.2	19.9	24.5	96	51	74	28.6
Nov.	1	30.7	19.4	25.0	98	48	73	21.9
	2	26.6	13.4	20.0	97	37	67	0
	3	27.6	12.3	20.0	97	37	67	5.2
Dec.	1	29.9	14.5	22.7	99	36	68	0
	2	26.5	12.6	19.5	98	37	67	12.0
	3	26.9	14.8	21.0	98	46	72	16.8

* 1: The first 10 days of a month.
* 2: The middle 10 days of a month.
* 3: The last 10 days of a month.

Table 9. Day Length

Month	Chiengmai	Bangkok
Jan.	11.08	11.24
Feb.	11.32	11.41
Mar.	12.02	12.02
Apr.	12.35	12.10
May	13.01	12.46
June	13.16	12.57
July	13.09	12.54
Aug.	12.45	12.36
Sep.	12.15	12.13
Oct.	11.44	11.50
Nov.	11.15	11.30
Dec.	11.01	11.19

PART I

CULTIVATION

HISASHI YARIMIZU

AMNUAY TONGDEE

THE ACTUAL INVESTIGATION OF SOYBEAN CULTIVATION IN THAILAND

Goals

In order to measure the development of soybean cultivation in Thailand, a study was made of the situation beginning with a study of the existing soybean cultivation. Also, in order to study the possibilities of the development of Thai soybeans, a Japanese expert was engaged to make a study of soybean cultivation in the dry season, from January to March, of 1969.

This study will endeavor to make a detailed study of soybeans cultivation both in the dry and rainy seasons so as to pin-point the problems of cultivation, and to research such problems if need be.

This study begins with the observation of the soybean cultivation areas during the 1970 rainy season so as to grasp the problems and development trends of each area. As to the cultivation during the rainy and dry seasons of 1971, the report selected various areas, and field researchers were sent out to each farm to interview the farmers. In conjunction with this, the author attempted to grasp the situation by the method of quadrant sampling in the soybean cultivating areas during the harvesting season.

The interviews were carried out with the cooperation and assistance of Mr. Ammuay Tongdee, the officer responsible for cultivation in the Department of Agriculture; the officer of the Mae Jo Agriculture Experiment Station and the Mae Jo Agricultural College in Chieng Mai Province; and the officers at the Srisamrong Agriculture Experiment Station in Sukothai Province.

The quadrant samplings at Chieng Mai and Sukothai were carried out with the assistance of Mr. Charoon Arry and Mr. Prayoon Suaytum of the Mae Jo Agriculture Experiment Station. The study in the Sukothai area was also carried out with the cooperation of Mr. Supachai Khaewmechai of the Department of Agriculture. The author would like to thank everyone involved with the study for their assistance and cooperation.

II. Method of Investigation

1) Locations Investigated

During the rainy season of 1970, soybeans was grown in 23 Provinces.

1. Undorn Thani	2. Kalasin	3. Roi - et
4. Khonkaen	5. Chaiyaphoom	6. Nakornrajasrima
7. Chiengmai	8. Lampang	9. Tak
10. Sukothai	11. Pitsnuloke	12. Phetchaboon
13. Lopburi	14. Singhaburi	15. Saraburi
16. Supanburi	17. Chachong Sao	18. Rajaburi
19. Kanchanaburi	20. Chainat	21. Phetburi
22. Prachinburi	23. Prachuab Khirikhan	

(1) Soybean cultivation in the rainy season of 1971

A. Investigation by questionnaire

Sukothai Province - Amphur Swankaloke
- Amphur Srisatchanalai

Chiang Mai Province - Amphur Sansai Amphur Mae Rim, Amphur Hangdong, Amphur Mae Tang, Amphur Sanpatong.

B. Locations of Quadrant Sampling

Sukothai Province - Amphur Swankaloke, Amphur Srisatchanalai

Chiang Mai Province - Amphur Sansai, Amphur Sri-ngan Amphur Mae Malai, Amphur Fang.

(2) Soybean cultivation in the dry season of 1971

A. Investigation by questionnaire

Chiang Mai Province - Amphur Sansai, Amphur Mae Rim, Amphur Mae Tang, Amphur Sanpatong.

B. Locations of Quadrant Sampling

Chiang Mai Province - Amphur Sansai, Amphur Mae Rim, Amphur Mae Tang, Amphur Sanpatong.

2) Study of Stems

(1) Soybean cultivation in the rainy season of 1970

1. Methods to control cultivation and development of soybean
2. Crop damaged by insects
3. Problem of nodule bacteria
4. Problem of storage and selection of seeds

(2) Soybean cultivation in the rainy season of 1971. (See Appendix I).

(3) Soybean cultivation in the dry season of 1971. (See Appendix II).

3) Number of Studies

(1) The study of soybean cultivation in the rainy season of 1970 was geared towards the growth and development of soybeans. The study was carried out by going out to the important soybean cultivation areas with the guidance of the extension officers of each province and interviewing the farmers. (Farmers are referred to as peasants, and Agriculture Experiment Stations and Colleges are referred to as persons in charge.)

(2) Soybean cultivation in the rainy season of 1971

A. Investigations by questionnaire

Sukhothai Province

Total questionnaires distributed	-50
Total questionnaires returned	-19

Chiang Mai Province

Total questionnaires distributed	-50
Total questionnaires returned	-50

B. Investigations by Quadrant Sampling

Sukothai Province - total 40
Chiang Mai Province - total 40
Grand total - 30

(3) Soybean cultivation in the dry season of 1971

A. Investigations by questionnaire

Chieng Mai Province

Total questionnaires distributed - 200
Total questionnaires returned - 200

B. Investigations by quadrant sampling

Chieng Mai Province - total 40

III. Results of the Studies

1) Soybean cultivation in the rainy season of 1970

At the present time, the soybean industry is growing at a rapid pace. Each individual area is growing soybeans according to the conditions of that area. The author feels that with some assistance and advice from the Government, the production will greatly be increased. Therefore, a study was made of the cultivation of soybeans by region for the purpose of finding out the methods of cultivation and the problems encountered by each region.

The stages of the development of soybeans, apart from the process of cultivation, include such stages as germination, reaping, shelling, and distribution. One study is not enough to deal with all stages, but this study attempts to present a true picture of the situation by interviewing the peasants and the persons in charge. The author also made field trips to the farms so as to obtain as true a picture of the conditions as possible.

1. Crop damage caused by insects

The dimishing yield of soybeans is mostly due to damage caused by insects and to the fact that the farmer is not able

to reap all of the crops in time.

Therefore, the study looks in detail at the problem of crop damage caused by insects.

(1) Danger from insects

In general, the birth and death of noxious insects depends upon the location and time of year, and usually, the percentage of crop damage depends on the time of cultivation of soybeans.

Table 1 shows the percentage ofcrop damage caused by noxious insects in each region at the time the study was made. The results of the study are estimates, and the author feels that this will be a major problem in the expansion of the soybean industry.

The amount and condition of damages depend on the location and the season of cultivation (dry or rainy). For instance, at Amphur Pakchong, Nakorn Ratchasima Province, the soybeans grown in June and harvested in December show 15% damage from hod borers and 7% from bean bugs, which is a rather high percentage of damage. From the study of stems on sale, it was found that there was a high percentage of damage caused by pod borers. It is felt that these stems came from soybeans grown in June or later in various regions. From the study of soybeans grown in May, June, and July at Amphur Fang, Chieng Mai Province, we find that the beans grown in May were greatly damaged by pod borers (32%) and that the beans grown in July were slightly damaged by bean bugs. Most of the farms showed damages caused by stem miners, some as high as 50%. Apart from this, it was found that the SJ 1 type of soybeans with a faster rate of germination than the SJ 2 type grown by the Irrigated Agriculture Experiment Station were greatly damaged by bean bugs and pod worms, whereas the SJ 2 type were damage by the stem

miners. From this, we can see the difference between the birth and life span of these noxious insects.

In Chieng Mai, the soybeans grown at the Mae Jo Agriculture Experiment Station in July and August showed no damage by insects. (The study of soybeans - slow rate of germination - grown in the dry season of 1969, showed a high percentage of damage by bean bugs. The beans die green.)

The soybeans grown in May, July, and August at Amphur Bantaic, Tak Province, clearly showed damage by bean bugs, despite the fact that DDT was used (once) during their development process. The soybeans in this area showed the most amount of damage out of all the soybeans studied. (The beans die green.)

At Amphur Swankaloke, Sukothai Province, which can be said to be the center of soybean cultivation during the rainy season at the time the study was made, most of the soybeans grown in May were in the process of being distributed. The seeds were inspected and it was found that they had been greatly damaged by bean bugs, some as high as 44%.

We can clearly see the danger coming from the bean bugs, pod worms, aphids, leaf rollers, stem miners, and others. As for the Root knot Nematodes, they appeared at the Mae Jo Agricultural College, Lampang Branch.

At present, preventive measures are being taken only in Tak Province. Generally, the cultivator is well aware of the dangers coming from the leaf rollers and stem miners, and he is also aware as to the time when these insects will strike and the danger they represent. As for the bean bugs, the cultivator will know only 10 - 20 days after the crop has been damaged.

During the harvesting time, no preventive measures are taken even though the cultivator is aware of the presence of these insects.

The author will not be able to make a continuous observation of these soybeans, but it is felt that these crops will be attacked by noxious insects again. Thus, so as todevelop a sound cultivation technique, it is imperative to grasp and understand the birth and life span of each type of insects in each region, the methods of crop rotation, mixed cultivation, and the economical methods of insect prevention by using insecticides.

(2) Crop - Destroying Diseases

The rainfall during the reaping period and the heat encountered in storage produce a disease called purple speck and cause the seeds to shrink, thus downgrading their quality. Therefore, the planting of soybeans is usually done in the rainy season, and the reaping is done when there is little rainfall. Despite this measure, the soybean seeds of Amphur Swankaloke, Sukothai Province, awaiting distribution showed a considerable amount of purple specks among them. The one important precaution that must be taken is after the beans are reaped and stored in the barn, when the humidity and heat could cause an outbreak of purple speck. (If the farmer has time, he will separarate the seeds from its shell thus preventing such an outbreak.) Therefore, it is very important to use modern machinery to shell and dry the seeds in time to prevent such outbreaks. This will mean an increase of the work involved but will help to maintain the quality of the seeds, which is a definite advantage in the trading of soybeans.

The leaf mosaic disease was found scattered among the soybeans grown at the Prabudhabbat Agriculture Experiment Station at Saraburi Province. The disease also appeared among the native kind of soybeans, purchased from the traders, grown by farmers in Kanchanaburi Province.

It can be said that the leaf mosaic disease is spread by seeds coming into contact with one another and could possibly spread throughout Thailand. Therefore, it is necessary to develop a sound method to distribute good seeds.

The rust disease is also quite common, especially in Chieng Mai, and the study shows a definite correlation between the degree of the disease present among the crops and the reduced yield. It is most important that the appropriate measures be taken.

2. Nodule Bacteria

It is a clear fact that the nodule bacteria is very dangerous to the bean family. The study shows that the nodule bacteria is rampant in the north-east, as shown in Table 2.

According to the study, the northeast region is most ideal for the nodule bacteria, and in the central region, the nodule bacteria will not appear among soybeans grown on high ground for the first time.

The Roi-ed Agriculture Experiment Station carried out experiments by growing the SJ 2 variety of soybeans, and the results showed that the majority of the beans were not affected by nodule bacteria. The nodule bacteria that did crop up was probably due to the accidental inclusion of other varieties of beans in the hills. The prabhudhabhat Agriculture Experiment Station carried out the same experiment and obtained similar results.

The chemistry section of the Roi-ed and Prabhudhabhat Agriculture Experiment Stations experimented by inoculating the nodule bacteria on their respective farms with success. Those farms that were not inoculated but were close by to the farms that were inoculated also showed signs of nodule bacteria. Among the varieties of soybeans there are other varieties other than SJ 2 that can be easily affected by the

nodule bacteria. Experiments are being carried out to separate these varieties.

More important, there are some types of nodule bacteria that grow well in the climate and terrain of the northeast, and more research should be made into this matter.

3. Germination of Soybean Seeds

It is an established fact that the soybean seeds are most effective, germination-wise, if kept in a dry place and at a low temperature. In Thailand, the climate is very hot and humid and it naturally follows that it is very difficult to retain the germination powers of the seeds if they are stored in the normal way.

For this reason, the farmer do not store seeds for future cultivation but will buy them from traders at 2.5-3.00 baht per kilo when the need arises. In Tak Province, the farmers "borrow" the seeds from the traders and pay back the "loan" with portions of their soybean crops.

In the case of farmers in Chiang Mai, however, the study revealed that the seeds stored from one rainy season until the next rainy season still retained high germination powers. The same applied to farmers in Nakorn Ratchasima, Patchong and Chaiyaphoom. The seeds are dried in the sun and stored intact in sucks which are kept in the farmers' homes. At Amphur Swankaloke, Sukothai Province, and at the Mae Fack Commune, Amphur San Sai, Chiang Mai Province, the farmers store the seeds reaped in the rainy season for cultivation in the next rainy season, by planting twice in the rainy season (October).

The author, in conjunction with the Mae Jo Agriculture Experiment Station, conducted a research on the rate of germination of soybeans using 21 varieties of seeds. Each of the 21 varieties of seeds were experimented with under various

conditions with the goal of finding a variety of soybeans suitable for cultivation in Thailand. The author also carried out experiments with regard to storage under various condition of seeds in conjunction with the Bangkhen Agriculture Experiment Station and the Mae Jo Agriculture Experiment Station. The results of the experiments will be mentioned later.

4. Selection of Seeds

At the present time, the SB 60 variety is the most widely used variety in Thailand (Pakchong, Sansai). However, about ten years ago, the SJ 1, SJ 2, and SJ 3 varieties, especially SJ 2, were introduced by the Agriculture Experiment Station and the Seed Multiplication Station with the aim of promoting the cultivation of soybeans.

The results of the field study showed that many varieties of seeds were grown together and that the yield was not as high as it could be. The amount of weeds present among the crops prevented the beans from developing fully, and the practice of filling the land while the beans were blooming resulted in many fallen blossoms, thus reducing the yield of beans. Therefore, a further study of the organization or system of the supply of soybean seeds should be made, and there should be a selection of seeds so as to promote a higher efficiency in the cultivation of soybeans.

The quality of the seeds will depend on the time that they are reaped. For instance, in the case of SJ 2, if this variety is reaped too late, the shells will turn to pale white and will loose its glossy shine, and the quality of the seeds will be low.

Another point of interest is that generally the bean seeds will fall whenever there is rain. The SJ 2 variety possesses a

non-shattering quality (hard hsells). If the seeds are left on the farm for about one month after their full growth, only about 2-3% of the seeds will be broken. (Experiments on germination of SJ 2 is mentioned earlier.)

It is possible that the non-shattering quality of the Thai soybean seeds is caused by the high temperature and humidity in Thailand. The SJ 2 variety could be used as one of the varieties to cross-breed in order to find a new variety of soybean (non-shattering quality).

Further study should be made of the corelation between the rate of germination and the time for reaping so as to set a definite time for the latter, and to obtain good quality seeds.

5. Method of Cultivation

Between the months of May - September, cultivation of crops in the rainy season (rotation of crops) will generally meet with various dangerous obstacles, mainly rainfall. The amount of danger involved will depend on how much importance the farmer places on the soybean crop. At Swankaloke, soybeans is the basic crop and thus the farmers in this region will grow soybeans during the most suitable month, that is, in May, and cotton will also be grown in between the soybean at the same time. After soybeans, the farmers will grow mung beans and black seeds. In Tak Province, the farmers will cultivate only once a year, also in May. In Chiang Mai, farmers also grow soybeans once a year in June, and many of them also grow at the same time longan fruits. However, in these areas where maize is the basic crop, soybeans will be grown in September (Lophuri Province), and where peanuts in the basic crop, soybeans will be grown in July. In the case of watermelons being the basic crop, soybeans will be grown in August and September.

When soybeans are grown in May and June, the beans, both SJ 1 and SJ 2, will grow to a height in excess of 80cm, even without fertilizers, because the days are longer at that time of year. In the case of soybeans grown in July however, the beans will grow to about 60cm. In the case of soybeans grown in May, the farmer will generally be faced with the problem of the beans growing too thick and lodging, thus reducing his yield.

There are still some farmers growing soybeans in June and July, and because of the lack of drying and threshing equipment, the crop will usually be destroyed by rain. The solution to this problem is not to delay cultivation until June and July. Not enough study has been made with regard to growing soybeans at an unsuitable time of year, and some farmers will continue to grow soybeans between August and September when the nights are long. Soybeans grown between May and June usually, but not always, provide a good yield. Therefore, studies should be made with regard to suitable conditions for cultivation so as to eliminate the problem of lodging, thus providing a longer yield.

Originally, the SJ 1 and SJ 2 varieties had a low resistance to lodging, and it is quite possible that this was related to the low germination rate of soybean seeds. Usually, more than 10 seeds are placed in the same hill, and the large number of plants per hill resulted in the plants being too thin, thus giving rise to the problem of lodging.

About 2 - 3 weeks after the planting, most of the farmers will carry out weeding only once. (It is important not to weed while the plants are blooming.) At such time, it is almost possible to distinguish between the soybean plants and the weeds. These weeds prevent the beans from developing fully thus causing the problem of lodging. This in turn reduces the yield of soybeans.

With regard to soybeans grown during the rainy season, the intertillage and siding of soil after the process of weeding can help to curb future growth of weeds and to prevent lodging. This point should be studied more in detail.

Another thing that must be mentioned is that in order to effectively prevent the growth of weeds, it is necessary to study the various types of weeds, their development process, and how to control them, either by farm management, or by rotation of crops, or by a special planting system. Also it is necessary to find a suitable chemical herbicide that can be used by farmers easily and cheaply.

This survey on soybean cultivation during the rainy season showed that the farmers used no fertilizers. Therefore, the yield per rai was quite low, only 155 kg/rai (1968). It is not as yet as to the correlation between the use of fertilizers and the increase in yield, but it is certain that the farmers do not use fertilizers because they cannot afford it.

Fertilizers play an important role in the promotion of agricultural products. In the future development of land, from infertile to fertile, there should be a study to determine the minimum amount of fertilizers needed to increase the yield. At the present time, the increase in yield of SJ 1 and SJ 2 resulting from the use of fertilizers, when compared to the increase in yield in Japan, is still low. However, it is necessary to continue to study this, and it is also necessary to have certain basic information on hand in order to promote a newer and better variety of soybeans.

6. Drawing up Standards for Experiments on Soybeans

Agricultural Experiment Stations and Seed Multiplications in Thailand have begun extensive research of soybeans on a large scale, and, through agricultural extensions, information concerning the growth process of soybeans should be

accumulated for study and comparison. However, as soybeans grown during the rainy season have different characteristics depending on location and method of cultivation, certain standard procedures with regard to the study should be laid down so as to facilitate the work of the Agricultural Experiment Stations.

2) Cultivation of Soybeans during the Rainy Season, 1971

(1) Sukothai Province

This province is located in the noth central region of Thailand. It is in the alluvial soil area, which is a good and fertile soil containing a lot of fertilizers. At the present time it can be said that this province is the center for soybean cultivation during the rainy season. Originally, this area was well known for its cotton, but not long ago, the cotton plantations were mostly destroyed by the American Boll Worm. Because of this, the area switched to soybeans 10 years ago, and later on also began to grow maize. It can be said that Sukothai is new-established land.

The quantity of soybeans cultivated per farm is very large, and the land is very fertile indeed and considered to be the most suitable location for soybeans.

The locations of investigated areas, shown in Chart 2, Table 3, show the conditions of cultivated land by crop per family. This shows that soybeans took up about 60% of the cultivated areas with cotton coming next. (Usually, cotton is grown between the soybeans plot.) Maize took up about 4% because the area investigated was a soybean area. However, maize is an important crop in other areas.

By interviewing the farmers, it was learned that 80.5% of the soybeans grown were of the SJ 1 variety, the remaining 19.5% being the SJ 2 variety. (Table 4) However, the

seeds are mixed, thus making it necessary to find quickly a way to supply good seeds to the farmers. This was explained in the report "Result of Actual Investigation" written last year.

Black seeds are also grown, especially when there is little rainfall. (The second phase of cultivation during the rainy season.) The balck seed type of beans have a high rate of germination and even, if grown on unprepared land, will produce the required amount of plants; also if there is little rainfall it is possible to obtain about the same yield from year to year. The seeds are cheap, and even if the yield is a samll, there are still many farms cultivating this variety.

One of the reasons as to why the farmers prefer to grow the SJ 1 variety during the rainy season is because it is easy to separate the seeds from the shells (by beating with sticks). (Table 5) Experiments carried out proved that the SJ 2 variety, when left for 22 days after reaping time, did not shatter easily (only 2-3% shattered). Therefore, when compared with the SJ 1 variety, we are inclined to agree with the farmers on this point. (The SJ 2 variety when grown during the dry season however will shatter easily. This will be mentioned in the section on cultivation in the dry season.) The Japanese variety shatters easily when the time comes for reaping, thus making the reaping process very difficult. With the introduction of shelling machineries (instead of beating with sticks) the variety used for cultivation was changed to non-shattering variety (even when left on the plants after full growth), thus increasing both the quality of the seeds and the yield. These factors, quality and yield, have now become the important factors. The farmers themselves would like to have shelling machineries but their high cost makes this prohibitive. At the present stage, there is

no information as to which variety, SJ 1 or SJ 2, will produce a larger yield when grown during the rainy season.

Seeds used for Cultivation

As shown in Table 4, about 63% of the farmers use the seeds they grow themselves for cultivation in the next year. These seeds generally have a low rate of germination as already mentioned in the report "Result of Actual Investigation" written last year. Since it is very difficult to maintain a high rate of germination for seeds grown in the early stages of the rainy season and then stored for more than six months for cultivation in the following rainy season, most of the farmers will grow a small amount of beans in September in the later stages of the rainy season, and these seeds will be used for cultivation in the following rainy season. Experiments are being carried out to find methods to maintain the rate of germination. (Report of Actual Investigation in 1970) The farmers who buy their seeds from the traders do so at an average of 3.9 baht per kilogram.

Methods of Soybeans Cultivation

Before cultivation, the land must first be plowed and most of the farmers use water buffaloes for this purpose. (15.8% of the farmers use tractors, Table 6). The farmers do not use fertilizers, but, as already mentioned, this region has rich alluvial soil with much natural fertilizers and is very suitable for farming. The farmers themselves are aware of the fact that about 31.8% of the land is very fertile, and about 63.2% is moderately rich. Because the farmers in this region grow cotton in between the rows of soybeans, the leaves of the beans are yellow and the distance between the rows is quite wide. (Table 7) Results of the study by interviews

are shown in Table 8, and the results obtained from quadrant sampling are shown in Table 10.

At the time the soybeans are grown early and mid May, the length of the days are the longest in the year and the ground holds a lot of moisture (beginning of the rainy season). Therefore, the beans will grow to their maximum capacity, and because of the wide distance between the rows, the branches and leaves will flourish and the beans will be large. Since the distance between the rows is very wide, the distance between the hills will be about 30-40 cm. This not only facilitates the growing of other crops in between the hills and rows but also helps to prevent lodging. In order to facilitate the control process such as weeding, tilling, and the use of buffaloes or a samll tractor, the problem of the density of plantation must be studied carefully.

In the case of soybeans grown in early and mid-May, the beans will be reaped in late August and early September. In early and mid-August however, the farmers will start to grow other crops among the soybeans. At this time, there is still some rainfall but not sufficient to stop sprouting. By September and October, rain will have ceased, thus making sprouting an uncertainty. Therefore the farmers beging to grow soybeans in early May because they are thinking of growing other crops in the late stages of the rainy season.

Despite the relatively thin density of plantation, there is still a large amount of lodging. This is caused mainly by the low rate of germination of the seeds (50%). The other reason is because of the characteristics of the soil in this region. The soil is a clayly loam which is a heavy soil. If a small amount of seeds is used, they will not sprout. Therefore, the farmers use about 8.5-12.1 seeds per hill thus giving rise to the problem of lodging (Table 8). The variety of seeds being used have small and weak stems and

a low resistance to lodging. Therefore, it is important to find a variety that will not only give a high yield but also have high resistance to lodging.

Preparation and Maintenance of the Land

Most of the farmers till the land and engage in weeding only once after the cultivation of soybeans. A very small minori till and weed 2 or 3 times (Table 10).

Most of the farmers use hoes for weeding, and some of then first use buffaloes to till the land and then use a hoe to weed between the plants (30%). Among this 30% some of the riche farmers employ a small plowing machine (mostly Japanese-made machines).

Since the first weeding and tilling are carried out during the rainy season, the weeds grow back very quickly (after 2 weeks). One weeding and tilling is insufficient to control these weeds, and more important there is no siding of soil whatever. If the farmers engage in siding of soil, it would help tremendously to control the growth of weeds, to prevent the stunted growth of soybeans, to strengthen the roots of the soybeans, and thus to decrease the amount of lodging. A more detailed study should be made into this matter.

The chief of the Agriculture Experiment Station asked the author whether the process of siding of soil will cause the roots of the soybeans to rot. The author did not have enough knowledge on this matter, but the experiments carried out by the Mae Jo Agriculture Experiment Station showed that the roots of soybeans grown in the rainy season did not rot, and that it controlled the growth of weeds and prevented lodging.

Birth of Noxious Insects

During the development of the soybeans, there was a small amount of rust disease detected.

The bean bugs appeared during the time of reaping (many varieties) and Aphids and the American Boll Worms also appeared at this time. About 42.1% of the farmers use insecticides once, but one spraying is not enough (Toxaphone and Rogor 40, for instance). Once the insects appear, it is very difficult, if not impossible, to control them.

Growth and Yield

As shown in Tables 11 and 12, the stems of the soybean plants are very big and the plants grow to height in excess of 80cm. The yield, when compared with that of other regions, is rather high. (In 1968, average yield for the whole of Thailand was 155 kilograms per rai.) Table 11 is the result of quadrant sampling (field trip by the author), and Table 12 is the result of interviewing the farmers. The yield of the latter is larger than that of the former because when the farmers say 1 rai, they usually mean more than 1 rai.

The soybeans, when reaped, are placed in stacks and then dried in the sun. The majority of the farmers use sticks to separate the seeds from the shells, and some use tractors or buffaloes to trample the shells. After using a winnower to blow away the shells, the seeds are then selected by sifting in a basket.

After the beans are reaped and stored in stacks, it is possible that they will be damaged because of the high temperature and humidity.

Sales of Soybeans

After the shelling process, about 66.7% of the seeds are sold immediately to the traders (October). The remaining 33.3% are sold around November. The price of soybeans for the past 2 years was 2.00 baht per kilogram.

(2) Chieng Mai Province

In Chieng Mai province only about 20% of the soybean cultivation is carried out in the rainy season. At such time the soybeans will be grown in the hilly regions, whereas during the dry season, they will be grown on low ground. This type of cultivation has been going on for about 30 years. Chart 2 shows the locations investigated.

The average size of the cultivated areas of soybeans per farm at Amphur Sansai is about 5 rais. (Table 14) This includes the Mae Fack Commune where soybeans are grown during the rainy season. (Both areas also grow a lot of tobacco.) At Amphur Sansai, about 76.2% of the farms investigated grow soybeans every year. (Table 15) The average size of the farms in this province, when compared to that of Sukothai Province, is approximately 10 rais.

The varieties of seeds used in Chieng Mai are similar to that used in Sukothai Province, SJ 1 and SJ 2. There are also many mixed varieties. At Amphur Hangdong, only 12.5% of the seeds used for cultivation are seeds kept by the farmers, but in other areas, most of the farmers used seeds they collect themselves (Amphurs Sansai and Mae Tang). Table 16.

At the Mae Fack Commune, Amphur Sansai, the farmers will collect the seeds grown in the rainy season for planting in the next the rainy season. But most of the farmers in other areas will grow the seeds collected in the rainy season in the following dry season.

Methods of Soybeans Cultivation

The conditions of the soil in this province, when compared to that of Sukothai Province, is not so rich. This is because of the high ground which causes an outflow of the nutritious substance from the soil. Also, because of the high temperature, the various minerals in the soil dissolve very quickly and are washed away with the rain. For this reason, it is very difficult to hope for a high yield.

As shown in Table 17, most of the tilling and other preparations of the land is done by human labour. The farmers do not use any type of fertilizers, and the management area is limited, causing an unfavorable economic condition. Apart from this, the varieties of seeds used have little reactions to fertilizers. Therefore even with the application of fertilizers, there is little hope for an increased yield.

The farmers generally grow a single crop, thus the distance between rows is very narrow and there is a high density of plantation. Table 18 shows the density of plantation, obtained by direct interviews, and Table 19 shows the same but obtained by quadrant sampling. The results are similar, that is, the distance between rows is from 30-50 cm, and the distance between hills is from 25-40 cm. There are about 2-4 plants per hill. Because of the large number of plants per hill, the stems of the soybeans are thin, thus giving rise to lodging. The farmers in the region, similar to those in Sukothai, say that because of the low rate of germination of the seeds, they fear that the seeds will not sprout, and therefore, they put in about 3-6 seeds in one hill.

Preparation and Maintenance of the Land.

Weeds grow very fast in this region, and about 80% of the farms investigated in Amphurs Mae Rim and Sansai engage

in weeding once. (Farms in other areas also weed only once.) About 15-25% of the farms investigated in Amphurs Sansai and Mae Tang engage in weeding twice (because of t large area of soybeans cultivation). Table 20. The meth of weeding is to use a hoe.

At the time this study was made, the soybeans were bloom and the farmers had just finished weeding. Despite this, t weeds had already grown back and were spread all over the field.

Only the farmers in Amphurs Hangdong and Sanpatong said that they also tilled the land at the same time of weeding. (The author believes that the farmers in other areas also till and weed at the same time.)

If there is siding of soil, the author believes that it will hel to curb the growth of weeds and to prevent lodging.

Birth of Noxious Insects

This year, the crop sustained a great dial of damage from the rust disease from the time of blooming up to the time of reaping. This greatly reduced the yield, and from what the farmers in the region said, the author learned that this condition has existed for the last 2-3 years.

It is very difficult to prevent this disease because of its occurrence during the rainy season. (The use of insecticides is very costly.) Apart from this, there is no insecticide that can completely curb this disease. There are some insecticides that can fight this disease, but it is not known how effective they are. Nevertheless it is clear that further research is still needed in this field.

With regard to noxious insects, the investigation found that Leaf Rollers and the Aphids were present everywhere. These types of insects can be easily detected. (Table 21) However

at the time the investigation was being carried out, the crop was hardly damaged by the bean bugs. (It was reported that this type of insects appeared only at Amphur Hangdong.) There are also some insects that are not visible to the naked eye and their presence is known only after the crop has been damaged.

The larger the area of cultivation, the more necessary it is to find out the fundamental data with regard to the birth and the life cycle of these insects.

At Amphurs Sansai and Hangdong, the farmers reported that insecticides had been used against the Leaf Rollers and the Aphids. No thought has been given to another insects.

Growth and Yield

Table 22 is the result of quadrant sampling, and Table 23 is the result of direct interviews with the farmers.

This year, the crop was greatly damaged by the rust disease as already mentioned.

The quadrant sampling taken at Amphur Sansai showed the highest yield - the maximum being 200 kilograms per one rai. At Amphurs Mae Malai and Fang, the crop was extensively damaged by the rust disease and the yield per farm was under 100 kolograms per rai.

The direct interviews with the farmers showed that the yield was fairly high, but at Amphur Sansai, the results were similar to that obtained by quadrant sampling. (The reason for this is that one rai, according to the farmers, was probably more than one rai.)

Most of the reaping is done by hand, and the seeds are separated from the shells by beating with sticks. The seeds are then collected by sifting in baskets. (Table 24)

Sales of Soybeans

The selling price of seeds, as shown in Table 25, is approximately 2.6 baht per kilogram. In general however, the seeds obtained from the crop grown in the rainy season will be sold totraders as seeds to be grown in the following season. (The price then is slightly higher.)

More and more farmers are keeping part of the seeds collected from the crop grown in one rainy season for cultivation in the following dry season. Most of the farmers investigated in Amphurs Mae Rim, Hangdong, Mae Tang, and Sanpatong, keeps the seeds collected from the rainy season crop. At Amphur Sansai, the investigation did not show this clearly, but most likely the situation is similar to the other regions.

3) Cultivation of Soybeans in the Dry Season of 1971

The investigation was carried out in Chieng Mai Province, where farmers have had the benefit of irrigation facilities for a long time. The region is also well know as a rice growing region. Originally, soybeans were grown on the dikes surrounding the paddly fields, but with the benefit of the irrigation of facilities, the farmers were able to grow soybeans in the paddy fields after the rice had been harvested.

Soybeans were first grown at Amphurs Sansai and Sanpatong 15-20 years ago; the beans were grown in the paddy fields during the dry season. Cultivation of soybeans was first started 10 years ago at Amphurs Mae Rim and Mae Tang.

It can be said that Chieng Mai Province is the soybean cultivation center of Thailand during the dry season, and that Sukothai is the center during the rainy season.

The cultivated area of soybeans per family is quite large because most of the paddy fields are large.

Table 27 shows that 65% of the cultivated area is taken up by soybeans. There are also some tobacco, peanuts, and garlic grown in the area. The percentage of cultivation of soybeans, peanuts, and tobacco at Amphur Sansai is similar to that at other Amphurs.

In general however, the farmers grow soybeans from year to year. (Table 28)

The most common variety of soybeans grown is the SJ 2 variety (Table 29), but there are also a lot of mixed varieties (similar to cultivation in the rainy season).

During the dry season, the beans will be left on the plants for about 8 days after their full growth, and about 36.6% of the beans will be shattered. (During the rainy season, despite the fact that the beans are left on the plant for 22 days, only 2-3% will be shattered.) The high rate of shattering is probably caused by the high temperature, low humidity, low water content in the soil, and the dryness of the weather in general. It is because of the high rate of shattering that the farmers like to grow the SJ 2 variety since they do not have to worry about shelling, and the yield is quite high.

Most of the farmers buy their seeds from the traders, and when compared with the farmers growing soybeans in the rainy season, the percentage of farmers buying seeds from traders is quite high. The price of the seeds is from 2.5 - 5 baht per kilograms depending on the variety of the seeds; the SJ 2 variety is the most expensive because of the high demand and the low supply.

Methods of Cultivation

Prior to cultivation, the farmer will flood the paddy fields despite the fact that the land has not been tilled. He will wait until the water subsides before he starts to plant. Most of the farmers will follow this procedure, and only a minority

will first plant and then flood the paddy field.

Some farmers burn the rice stubble in the paddy fields before planting the soybeans, some cut the rice stubble, and some just let the stubble stand as they are and plant the soybeans by sowing.

The farmers usually use a stick or a piece of bamboo, about 1 meter long, to make a hole in the hills before planting. This requires a great deal of labor. There are also some farmers who sow the seeds on the ground without even tilling the land. (At Amphur Saupatong, about 18.3% of the farmers employ this method.)

Most of the farmers use dry water cow dung, highs feces, or bird droppings as fertilizers instead of turning over the soil; some farmers also mix rice straw ashes with animal waste, and only a minority use chemical fertilizers. (Table 30)

(The quality of the soil in the paddy fields is average.)

The density of soybean plantation depends upon the density of rice plantation. As some farmers plant soybeans in between the rows of rice stubble, and some by the rice stubble, the distance between the rows of soybeans is from 25-42cm, and the distance between the hills is from 25-36cm. The number of plants per hill, as explained in the section on cultivation in the rainy season, is from 2-5 plants. (The low rate of germination makes it necessary to put in from 4-6 seeds in one hole.) (Tables 31 and 32)

The season for planing soybeans falls between early and mid-January. It cannot be earlier than this because the water from arterial waterways will not be flowing; and the short length of the days will make the beans grow slower. If the beans are planted later, say in February or March, the longer days will make the beans grow faster, but the beans will have to be reaped in May or June, which will affect future plantings. Also, there will be no water from

the arterial waterways in April - June, making it necessary to plant in early or mid-January.

Preparation and Maintenance of the Land

Because the farmers do not till the land before planting, weeds grow in abundance. Apart from this, some farmers flood the paddy fields, thus making it that much easier for weeds to gorw. Since the soil is in a paddy field, it is a heavy and hard soil with a high viscosity, making the job of weeding and tilling a difficult and heavy job. For this reason, most of the farmers do not engage in weeding and tilling (Table 33), and while the beans are blooming, their growth will always be hampered by the weeds. The weeds prevent the beans from developing fully thus making it impossible to hope for a high yield. Even though the problem of the weeds is overcome, the shortness of the days in the dry season will prevent the beans from developing fully, thus also making it impossible to obtain a high yield.

In general, the yield of soybeans in the dry season is low because the farmers do not till the land prior to planting. If the land is tilled prior to planting, as in the case of peanuts, the weeds wil grow back at slower rate thus allowing the beans to develop fully. Also it will be easy to control the growth of weeds. The farmers themselves are well aware of the dangers that the weeds present, but they say that they would rather use the time needed for weeding for planting another crop of soybeans. The yield they receive from these two crops would roughly equal the yield of one crop with prior tilling and weed control. The author feels that this attitude will always be a problem in the future development of soybeans cultivation.

If the farmers are to be persuaded accept that fact that, if the dangers from the growth of weeds are eliminated, the

yield would be increased by many old, it is necessary to study in more detail the methods of cultivation, methods of control and maintence, including the use of herbicides to curb these weeds.

Methods of Irrigation

During the dry season, there is no rainfall at all and soybeans can be grown only in those paddy fields that can be flooded. Generally, the famers will flood the paddy fields used for growing soybeans twice a month. At Amphur Sanpatong, some farmers flood the paddy fields 3 times a month. (Table 34) The amount of flooding depends on the circumference and the area of the paddy field. The farmers will dig 2-3 drainage ditches about 30cm. wide to allow the water to flow into the paddy field. In the beginning, the whole paddy field will be under water and the beans will have too much moisture, but after 2-3 days, the paddy field will be dry again. The beans will grow under this changing condition, from too dry to too much moisture.

From studies made in Japan concerning the amount of moisture needed for the growth of soybeans, it was discovered that the beans will grow best if the amount of moisture in soil can be maintained at a certain level, and the yield will increased tremendously. If the condition of the soil is not stable, i.e., sometimes dry, sometimes moisture, the beans will not grow well, thus giving rise to fallen buds; the seed will be small and the yield will be low. Therefore, no matter what actions are taken, soybeans grown in the dry season in Thailand will not give a high yield if such unstable conditions of the soil still exist.

There is no data concerning the amount of moisture in the soil suitable for the growth of soybeans. However, from

data collected from other countries, we can estimate that about 70% moisture in the soil is most suitable. It is very important to study this aspect of cultivation in more detail. From what has been said, we can conclude that the present method of irrigation of flooding the paddy fields should be stopped. It would be for soybeans that let the water into the fields by way of these ditches and thus eliminate the danger of water flooding the bean plants root.

At present, the farmers flood the paddy fields once every two weeks, but in order to prevent the plants from drying up, it is necessary to water them every 5-6 days. From experiments made by the author, it was discovered that the soybeans need more water when they are nearly fully developed. But the farmers stop flooding the padddy fields when the plants are only half grown. The water from the arterial waterways is also stopped, preventing the beans from developing fully and making the seeds samller. If the farmers give sufficient water to the dry season crop, the seeds will be larger by 10-20% (generally, 100 seeds will weigh about 12-12 kilograms).

From now on, it is hoped that the farmers will sufficiently water the beans until they are fully developed. This will increase the yield and make the seeds larger. (The insufficient amount of moisture in the soil dries up the leaves of the soybean plants.)

(At Amphur Sapatong, it was reported that the roots of the plants rotted because of too much moisture in the soil. Generally, when there is too much moisture in the soil, the leaves and stems will not develop fully, the leaves will turn yellow and fall of, and eventually, the plant will dry up and die.)

Birth of Noxious Insects

So far, there has been no report of extensive crop damages caused by insects. The insects consist of Leaf Rollers, Aphids, and Bean Bugs (similar to the rainy season). At Amphurs Sansai and Sanpatong, about 23-24% of the farmers spray once against the Leaf Rollers. (Table 35) The spraying against the Bean Bugs causes a lot of trouble. Nevertheless, as already mentioned, it is necessary to study in detail the births and life span of these insects and to find ways of eliminating them.

Growth and Yield

As shown in Tables 36 and 37, the soybean plants grown in the dry season must be large in order to obtain a high yield. Chart 4 shows the results of quadrant sampling of the correlation between the weight of the seeds and the weight of thebranches. It can be said that the heavier the weight of the branches, the higher the yield. For this reason, it is necessary to improve the density of plantation, to use proper irritation methods, and to control the growth of weeds. Table 37 shows the results of interviewing the farmers, and it can be seen that the SJ 2 variety gives a higher yield than the SJ 1 variety.

The beans are reaped by sickle and the seeds are separated from the shells by beating with sticks as in the case of the rainy season crop. The methods of drying and grading are also the same. At Amphur Sanpatong however, only 17.5% of the farmers grade the seeds. The method of distribution is the same, i.e., mixed variety, giving rise to the low quality of seeds. This aspect must be studied further.

With regard to sales of seeds to traders when compared to the year 1969, the price of seeds was higher in 1971 because

of the smaller yield (about 2.2 baht per kilogram). (Table 39) As for the percentage of farmers keeping the seeds for future cultivation and consumption (Amphur Sanpotang), it was 1969-55.0%, 1970-62.7% and 1971-97%, showing an annual increase. Among this lot, the amount of seeds kept for future cultivation is as follows:- 1969-38.8% kilograms, 1970-37.0 kilograms, and 1971-50.0 kilograms.

4) Summary

This report is the result of the actual investigation of soybeans cultivation in the rainy season of 1970 and in the dry season of 1971. There are many problems and it is necessary to study the subject in detail and to advise the farmers accordingly in order to solve the various problems.

Therefore, it is imperative to have research equipment, sufficient funds, and qualified experts to successfully carry out the job. The progress of research carried out in other countries has revealed many astounding facts. Therefore, it is suggested that the Department of Agriculture keep up with this progress by referring to these studies when carrying out their own experiments.

The researchers of each experimental station should carry out their own research, and there should be a nation-wide convention bringing together all the researchers for the purpose of exchanging ideas and so forth.

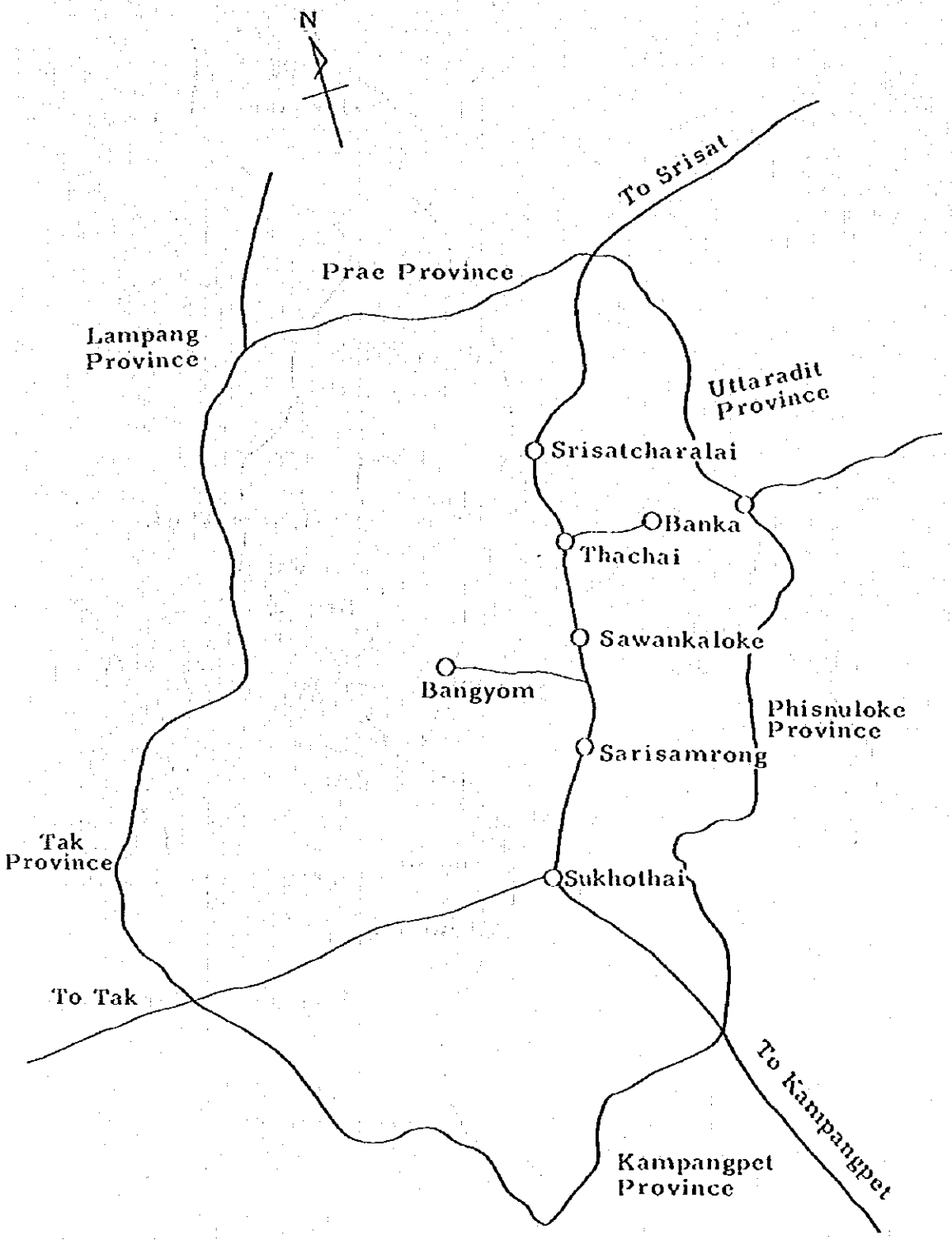
In this way, all the information available can be accumulated and assessed thus giving some meaning to each individual experiment.

Another point to remember is that no matter how successful an experiment may be, it will be meaningless if the farmers do not accept it and put it into practice. Therefore, it is very necessary to have a good public relations program to educate and advise

the farmers with regard to the various aspects of cultivation. The adaption of this policy will enable the farmers to benefit from such experiments as this one, which will in turn help to promote the development of the Agricultural Sector of the economy.

Chart 1 Locations Investigated

(Sukhothai Province)



Place of Investigation

Chart 2 (Chieng Mai Province)

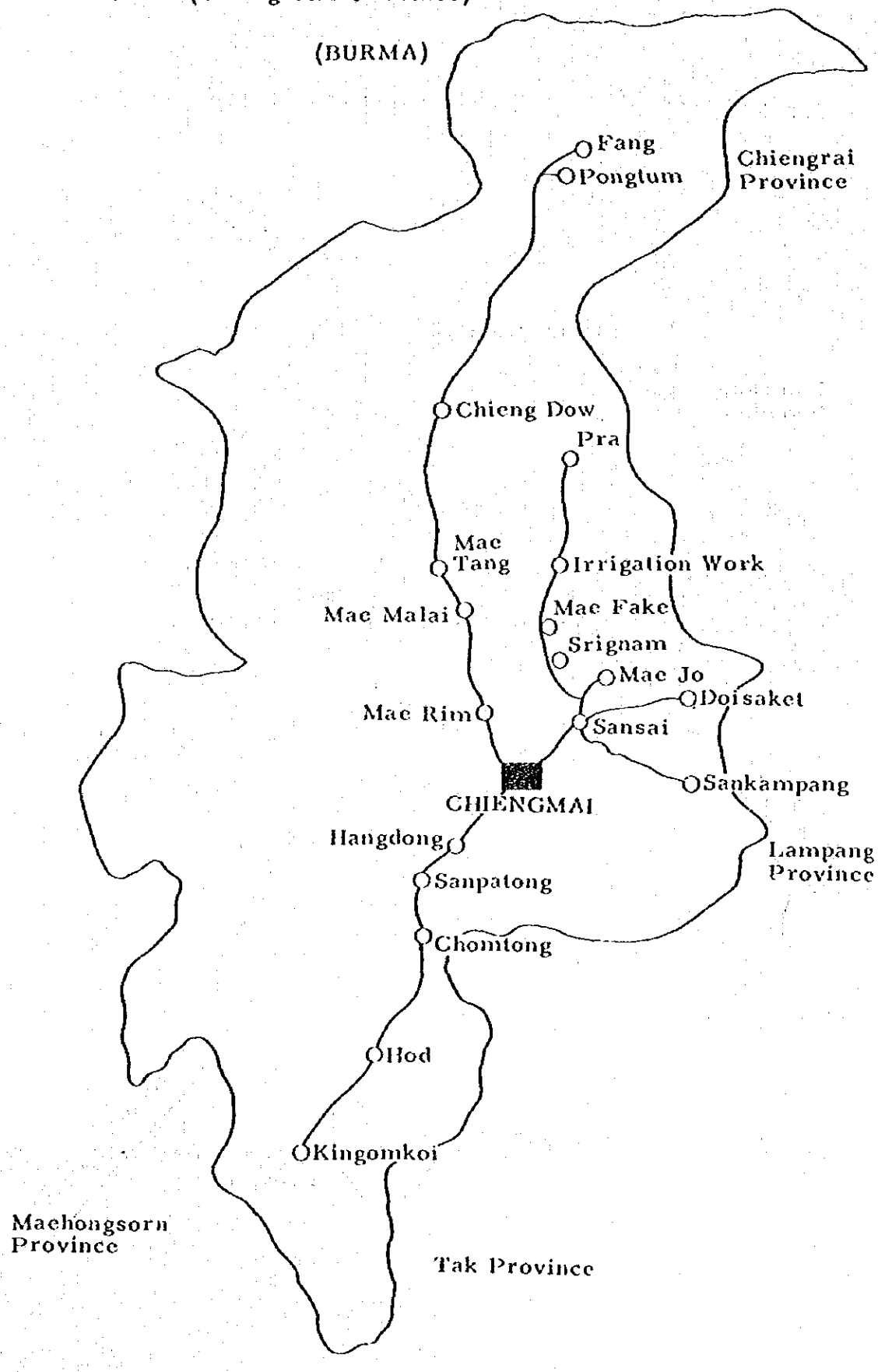


Table 1. Investigation of Crop Damage Caused by Insects

Location Investigated	Planting time	Varieties	Type of Insects	Rate of Damage (%)	Remarks
Chiengmai Province Amphur Moe Rim	1) Early May	Native kind	Pod worm	Rate of Stems damaged 38	After the investigation was completed, the soybean crop was greatly damaged by Bean Bugs, and the yield was only 105 kg/rai.
	2) Late June	SJ 2	Bean bugs	Rate of seeds damaged slight	
Chiengmai Province Mae Tang	1) Late June	SJ 1	Bean bugs Pod worm	Medium	The SJ 1 type with quick germination powers will receive much damage from bean bugs & pod worms.
Experiment Station		SJ 2	Stem miner	Rate of stems damaged medium	The SJ 2 type with slow germination powers will be damaged by the stem miners.
Chiengmai Province	1) Early in May	SJ 1	Bean bugs	Rate of seeds damaged 32	
Amphur Fang	2) Early in May	SJ 1	Bean bugs	17	
	3) Middle of July	Native kind	Stem miner	Rate of stems damaged 50	
			Bean bugs	Very slight	

No.	Location Investigated	Planting time	Varie-ties	Type of Insects	Rate of Damage (%)	Remarks
4	Chiengmai Province	1) Early in June	SJ 1	Bean bugs	Rate of seeds damaged 11	
	Sansai District	2) Middle of June	SJ 1	Bean bugs Aphids	regligible regligible	
5	Chiengmai Province Mae Joa Agriculture College	1) Middle of June	SJ 2	Bean bugs Root knot nematodes	regligible Slight	
6	Tak Province Bantarg District	1) Late May	Native kind	Bean bugs Stem miner Pod worm	76 slight slight	The beans d green in the
		2) July	Native kind	Bean bugs	8	
		3) August	Native kind	Bean bugs		
7	Saraburi Province	1) Early July	SJ 1	Bean buys	Rate of seeds damage 5	
	Praphutabaat District	2) Early August	SJ 2	Bean buys	11	
8	Lopburi Province Lammnarai Dist.	1) Early July	SJ 1	Stem miner	Slight	
9	Phisnulok Prov. Vangthong Dist.	1) August	SJ 2		0	

Location Investigated	Planting time	Varieties	Type of Insects	Rate of Damage (%)	Remarks
Sukhothai Prov. Sawankalok Dist.	1) Late May	SJ 1	Bean bugs	13	
	2) May	Unidentified	Bean bugs	11	Seed were infected before shipment
	3) May	"	Bean bugs	14	"
	4) May	"	Bean bugs	20	"
	5) May	"	Bean bugs	44	"
	6) May	"	Bean bugs	26	"
	7) May	Black bean	Bean bugs	6	"
	8) May	"	Bean bugs	25	"
	9) August	SJ 1	Bean bugs	Slight	
	10) Early Sept.	SJ 1	Aphids	Slight	
Phetchaboon Prov.	1) Early	Native kind	Stem miner	Rate of stems damaged medium	
Vichienburi Dist.		Pod worm	Pod worm	Branch damaged Slight	
	2) Mid August	Native kind	Aphids	Slight	
Chainat Prov. Chaophraya River Experiment Station	1) June	Many Varieties		00	
Supanburi Pro. Uthong Agriculture Experiment Station	1) Middle of July	SJ 2	Bean bugs	21	
Kanchanaburi Prov.	1) Late July	Native kind	Bean bugs	Seeds damages slight	
Muang District	2) Late July	Native kind	Stem miner	Stem damaged medium	

No.	Location Investigated	Planting time	Varieties	Type of Insects	Rate of Damage (%)	Remarks
15	Prachuab Khirikhan	1) Sept.	Native kind	Leaf roller	Leaves damaged medium	
		2) Early Sept.	Native kind	Leaf roller	Leaves damaged medium	
16	Mahasarakam Prov.	1) -	SJ 2	Bean bugs	Seeds damaged 24	
	Mahawarakam Agriculture Experiment Station	2) -	Native kind	Bean bugs Pod borers	2 5	
17	Nakornrajasima Prov. Pakchong Dist.	1) Middle of June	Pakchong	Pod borers Bean bugs	15 7	

Note: Rate of damage

Very slight		- 10%
Slight	11	- 30%
Medium	31	- 50%
Much	51	- 80%
Maximum	81	- 100%

Table 2. Investigation of the Birth of Nodule Bacteria

No.	Location Investigated	Varieties	Birth of Nodule Bacterid Yes (O) No (X)	Conditions with regard to other types of nuts
1	Nokornrajisima Prov. Farmhous in Packchong Dist.	1) Native kind 2) Native kind 3) Native kind 4) Native kind	O O O O	
2	Nakornrajisima Prov. Non-soong Agri. Exp. Sta.			Gua O Indigofera hersuta O
3	Khonkaen Prov. Khonkaen Seed Multiplication Sta.	SJ 2	X	Peanuts O Cortelaria O Cowpea O Cowpoon O
4	Chaiyaphoom Prov. Chaiyaphoom Seed Multiplication Sta.	SJ 2	X On land just beginning to grow beans	Peanuts O on land just beginning to grow peanuts Cowpea O Cortelaria O
5	Kalasin Prov. U.N. Pilot Farm for Irrigated Agri.	70 Varieties (include, SJ 1, SJ 2 native kind) 1. kind	O X	
6	Kalasin Prov. Seed Multiplicate Stations	16 Varieties	X On land just beginning to grow bean	Peanuts O presently 3rd growing also same with 2nd growing Cortelaria O Cowpea O

No.	Location investigated	Varieties	Birth of Nodule Bacterid Yes (O) No (X)	Conditions with re to other types of n
7	Roi - et Province Roi - et Agriculture Experiment Station	At place of cultivation SJ 2 variety, even though grown in the same field, will come out O, X. Depens on the location. The hill growing mixed varieties came out O (white flower) and the hill growing SJ 2 (purple Hower) also came out O. In nodule bacteria inoculation Experiment field, both inoculated & uninoculated places turned out	O	Peanuts O Nuing bean O
8	Udornthani Prov. Farmhouse	Native kind	O	Peanuts O
9	Chiengmai Prov.	360 Varieties (include SJ 1 SJ 2, Native kind)	O	Peanuts O
10	Chiengmai Prov. Mae Jo Agri. Exp. Sta.	SJ 2	O	
11	Chiengmai Prov. Fang Farmhouse	1) Native kind 2) Native kind	O	
12	Chiengmai Prov. Mae Rim farmhouse	SJ 2	O	
13	Chiengmai Prov. Sansai farmhouse	1) SJ 1 2) SJ 1 3) SJ 1	O O On land just beginning to grow beans O	
14	Chiengmai Prov. Mae Tang Agri. Exp. Sta.	1) SJ 1 2) SJ 2	O O	

No	Location Investigated	Varieties	Birth of Nodule Bacterid Yes (O) No (X)	Conditions with regard to other types of nuts
15	Lampang Prov. Mae Jo Agri. College Lampang Branch	SJ 2	O On land just beginning to grow beans	
16	Lampang Prov. Lampang farmhouse	SJ 2	O	
17	Chachoengsao Prov. farmhouse	Native kind	O	
18	Saraburi Prov. farmhouse	1) Native kind 2) Native kind	O O	
19	Saraburi Prov. Prabudhabhat Agri. Exp. Sta.	1) Similar to the case of Roi-et Agriculture Experiment Station growing SJ 2; even though grown in the same field, will turn out OX depending on location. Hill growing mixed kind will turn out 0, and SJ 2 growing nearby will mostly turn out as O. 2) In nodule bacteria inoculation Exp. field, both inoculateds and uninoculated palces are O. 3) Experiment varieties such as SJ 1, Bon-minori are X.		
20	Lopburi Prov. Lamnarai farm house	1) SJ 1 2) Native kind 3) Native kind	O O O	
21	Tak Prov. farmhouse	1) Native kind 2) Native kind 3) Native kind	O O O	

No.	Location Investigated	Varieties	Birth of Nodule Bacterid Yes (O) No (X)	Conditions with reg to other types of nu
22	Phismulok Prov. farmhouse	SJ 2	O On land just beginning to grow bean	
23	Sukhothai Prov.	1) Native kind	O	
	Sawankaloke farmhouse	2) Native kind	O	
24	Phetchaboon Prov. farmhouse	1) Native	O On land just beginning to grow beans	
		2) Native	O	
		3) Native	O	
25	Chainat Prov. Chaophraya River Exp. Station	SJ 2	O	
26	Supanburi Prov. Uthong Agri. Exp.	SJ 2 Bonminori	Depend on places OX	Peanuts O
27	Kanchanaburi Prov. farmhouse	1) Native kind	O	
		2) Native kind	O	
		3) Native kind	O	
28	Prachuabkhirikhan Prov.	1) Native kind	X on land just opened for cultivation and growing soybeans.	Ped beau O onland just opened for cultivation
		2) Native kind	X many years of growing soybeans after opened for cultivation.	
		3) Native kind	X on land growing soybeans for the first time after opened for cultivation.	

Table 3. Cultivated Area (rai) (average per farm)

Soy bean	%	Cotton	%	Maize	%	Upland rice	%	Total of Cultivated Area	%
25.3	60.7	11.9	28.5	3.9	9.4	0.6	1.4	41.7	100

Table 4. Varieties, Sources, and Prices of Seeds

Name of soy-bean varieties	%	Sources	%	Price of seeds
SJ 1	80.5	from their own farms	63.2	3.9 Baht/1kg
SSJ 2	19.5	from traders	26.8	

Table 5. Methods of Harvesting and Preparation

Method of reaping	Method of shelling		Method of drying	Method of grading
Sickle	by sticks	68.3	dry in the sun for 3-4 days	After use of winnower then selected by hand sifting
	by tractors	26.3		
	by baffaloes	5.3		

Table 6. Methods of Plowing

Method of	%
By buffalo	64.8
By human power	15.8
By tractor	15.8

Table 7. Trend of Cultivations

1969			1970			1971		
		%			%			%
Soy bean	Cotton	38.8	Soy bean	Cotton	52.6	Soy bean	Cotton	52.6
Soy bean	Maize	46.2	Soy bean	Maize	47.4	Soy bean	Maize	49.4

Table 8. Density of Planting (Obtained from interviews with farmers)

Time of planting		Distance betweeh	Distance between hills	Volume of seed sown (kg/rai)	No. of seeds sown per hill	No. of plants per hill
month	day	cm.	cm.		8.5 -	5.1 -
5	19	121.1	37.6	5.9	12.1	6.3

Table 9. Density of Planting (result of quadrant sampling)

Investigated area	Name of varieties	Time of planting	Time of harvesting	Distance between rows(cm)	Distance between hills(cm)	No. of plants per hi
Srisatchanalai dist	SJ 1	Early May	Late in Aug.	131.4	43.3	4.1
	Black soybean	Early May	Late in Aug.	130.0	30.0	3.7
Bankoa	SJ 1	Early May	Late in Aug.	130.0	40.0	4.8
Swankalok dist	SJ 1	Mid-May	Late in Aug.	92.7	39.0	3.7
Bangyom	Black soybean	Early May	Late in Aug.	Scatter all over	-	1.0

Table 10. Preparation of Land

Weeding			Method of weeding		Cultivating			Method of cultivating
1st	2nd	3rd			1st	2nd	3rd	
38th day after planting	45th day after planting	55th day after planting	hoe	% 47.3				Done in conjunction with weeding
Among investigated farms	Among investigated farms	Among investigated farms	Buffalo (cultivator)+hoe	31.5	Among investigated farms	Among investigated farms	Among investigated farms	
100% Reported weeding	6% Reported weeding	0.5% Reported weeding	Tractor (small size)	21.2	84.2% plowing	0.5% plowing	0%	

Table 11. Growth & Yield (result from quadrant sampling)

Investigated area	Name of plant	Plants' height (cm)	No. of nodes of main stem	No. of branches per hill	Weight stems	No. of pods per hill	Weight 100 seeds	Weight seeds (kg/rai) (gr)	Remarks
Srisatchanalai Dist	SJ 1	103.4	18.4	26.7	196.8	588.2	11.4	212.7	
	Black bean	47.2	9.7	14.5	92.2	155.0	9.7	145.0	
Bankoa	SJ 1	83.4	18.1	33.6	172.8	502.1	10.6	226.2	
Swankalok Dist.	SJ 1	88.8	17.6	26.4	130.4	478.3	11.7	154.7	
Bangyom	Black bean	42.8	10.5	3.2	11.5	30.7	10.8	137.6	Overall planting

Table 12. Yield (obtained from interviews with farmers)

Name of plants	Weight of seeds (kg./rai)
SJ 1	234.1
SJ 2	235.0

Table 13. Sales of Soybean

Selling price Baht/1kg.			Customers
1969	1970	1971	1969-1971
1.9	2.0	2.0	Traders 100%

Table 14. Cultivated Area (average per farmhouse)

Location investigated	Cultivated area of soybean		Cultivated area of other crops		Total Cultivated area	
	rai	%	rai	%	rai	%
Sansai	5.0					
Mae rim	1.6	16.0	8.4	84.0	10.0	100
Hangdong	1.8	16.7	9.0	83.3	10.8	100
Mae tang	2.9	21.6	10.5	78.4	13.4	100
Sanpatong	0.8	11.8	6.0	88.2	6.8	100

Table 15. Trend of Cultivation of Crops

Location Investigated	1969	1970	1971	%	Remark
Sansai	July, Aug. Tobacco July, Aug. Tobacco July, Aug. Tobacco June - Soybean	July, Aug. Tobacco July - Maize June Soybean June Soybean	June - Soybean June - Soybean June - Soybean June - Soybean	14.2 4.8 4.8 76.2	After harvesting of soybean, water melons & garlic are grown.
Mae Rim	June - Soybean	June - Soybean May - Peanuts	June - Soybean June - Soybean	93.8 6.2	
Hangdong	June - Soybean	June - Soybean	June - Soybean	100	
Mae Tang		June - Soybean	June - Soybean	100	
Sampatong	June - Soybean	June - Soybean	June - Soybean	100	

Table 16. Varieties, Sources, Prices of Seeds

Location Investigated	Soybean Varieties	%	Sources of seeds	%	Price of seed Kg/baht
Sansai	SJ 1	100	their own farms from trader	60.0 40.0	3.0
Mae Rim	SJ 2	100	their own farms from trader	62.5 37.5	2.4
Hangdong	SU 1 SJ 2	50.0 50.0	their own farms from trader	12.5 87.5	3.2
Mae Tang	SJ 1 SJ 2	25.0 75.0	their own farms from trader	75.0 25.0	2.2
Sanpatong	SJ 2	100	their own farms from trader	50.0 50.0	3.0

Table 17. Methods of Plowing

Location Investigated	Method of plowing	%
Sansai	Human labor	100
Maerim	Buffalo	6.3
	Tractor	12.5
	Human labor	81.2
Hangdong	Buffalo	62.5
	Human labor	37.5
Mae Tang	Human labor	100
Sanpatong	Human labor	100

Table 18. Density of Planting (obtained from interviews with farmers)

Location Investigated	Planting Time	Distance between rows	Distance between hills	Volume of seeds kg./rai	No. of seeds per hill	No. of plants per hill
		cm.	cm.			
Sansai	Early June 80% middle of "20	48.0	41.0	5.2	5-6	2-3
Maerim	Late May	29.1	25.0	7.1	4-5	3-4
Hangdong	Late April early June	43.8	39.4	7.6	3-4	2-3
Maetang	Middle of May late June	31.1	25.0	6.6	3-5	2-3
Sanpatong	Middle of May middle of June	45.0	30.0	6.0	3-5	2-3

Table 19. Density of Planting (results of quadrant sampling)

Location Investigated	Planting Time	Harvesting Time	Distance between rows(cm)	Distance between hills(cm)	No. of plants per hill
Sansai	Early June	19 Sept.	47.5	38.5	2.6
Sringan	Early June 80% late June 20%	18 Sept.	41.7	38.0	2.5
Mae Malai	Early June 20% middle June 80%	23 Sept.	44.0	44.0	2.3
Fan	Early July	2nd Oct.	50.0	20.0	2.0

Table 20. Preparation of Land

Location Investigated	Weeding			Time of Weeding	Plowing			Method of Weeding
	0	1st	2nd		0	1st	2nd	
	%	%	%			%	%	
Sansai	20.0	80.0	15.0	1st time-on 20th - 40th germination 2nd time - before blooming				Ground is time of weeding
Mae Rim	18.7	81.3	0	Late June early May				Ground is time of weeding
Hangdong	-	100	0	Early July late June	100			Ground is time of weeding
Mae tang	-	100	25.0	Late July late June				Ground is time of weeding
Sanpatong	-	100	0	Early July	100			Ground is time of weeding

Table 21. Birth of Insects and Pest Prevention

Location Investigated	Name of Insects	Time of birth	Time of spraying	Name of chemicals
Sansai	Leaf roller aphids All farmers interviewed reported the outbreak	Blooming Pruning time	Blooming period pruning time 35% of the farmers interviewed reported spraying	Lannet Bazudrin Endex DDT.
Mae Rim	Aphids Cut worm All farmers interviewed reported the outbreak			
Hangdong	Aphids Bug Leaf roller 87.5% of the farmers interviewed reported the outbreak	1 month after planting 15% of the farmers interviewed reported spraying		Sevin 75
Mae tang	Aphids Cut worm Jassid			
Sanpatong	Jassid Worm			

Table 22. Growth, Yield (result of quadrant sampling)

Location Investigated	Varieties	Stem height (cm)	No. of main stem	No. of brands per hill	Weight of stems (kg/rai)	No. of pods per hill	Weight of 100 seeds gr.	Weight of seeds (kg/rai)
Sansai	SJ 1	77.6	16.8	17.9	143.5	240.1	8.7	133.0
Sringam	SJ 1	77.3	16.4	17.6	193.5	219.1	9.5	112.8
Mae Malai	SJ 1	76.0	16.6	15.6	225.8	174.1	7.5	20.4
Pan	SJ 2	46.8	11.9	10.8	218.4	73.0	6.0	70.4

Table 23. Yield (obtained by interviews with farmers)

Location Investigated	Varieties	Weight of Seeds (kg./rai)
Sansai	SJ 1	126.8
Mae Rim	SJ 2	45.9
Hangdong	SJ 1 = 33.3% SJ 2 = 66.7%	172.5 160.8
Mae Tang	SJ 1 = 50% SJ 2 = 50%	97.5 35.5
Sanpatong	SJ 2	202.5

Table 24. Methods of Harvesting and Preparation

Location Investigated	Method of reaping	Method of shelling	Method of drying	Method of grading
Sansai	By sickle	By club	dry (sun) 2-3 days	Sifting in baskets
Mae Rim	By sickle	By club or stick	4-5 days	Sifting in baskets
Hangdong	By sickle	By club or stick	Dry in the sun	Sifting in baskets
Maetang	By sickle	By club	4-5 days	Sifting in baskets
Sanpatong	By sickle	By stick	5 days	Sifting in baskets

Table 25. Sales of Soybean

Location Investigated	Sales Price Baht/1kg.			Customers
	1969	1970	1971	
Sansai	2.5	2.3	2.4	Trader
Mae Rim	2.1	2.1	3.0	Trader
Hangdong	2.7	2.8	2.6	Trader
Maetang	2.1	2.5	2.4	Trader
Sanpatong	4.0	2.8	2.4	Trader

Table 26. Preservation of Seeds

Location Investigated	Preservation of Seeds		
	1969	1970	1971
Sansai	0	0	
Mae Rim	0	0	For cultivation in the following dry season 6% of the farmers
Hangdong	For cultivation in the following dry season 1.3% of the farmers	" "	100% of the farmers
Maetang	-	-	100% of the farmers
Sanpatong	For cultivation in the following dry season 50% of the farmers	" "	100% of the farmers

Table 27. Cultivated Area (average per farm)

Location Investigated	Cultivated area of soybean		Acultivated area of others		Area of holding paddy field		Total of cultivated area
Sansai	rai	%			rai	%	rai
Sansai	4.8	66.1	-	-	11.8	100	19.5
Maetang	5.7	44.5	-	-	12.8	100	18.5
Maerim	6.6	81.5	-	-	8.1	100	14.7
Sunpatong	6.3	81.8	0.1	0.1	7.7	100	14.1
Average	6.6	65.3	0	0	10.1	100	16.7

Table 28. Trends of Cultivation of Crops

Location Investigated	1970	1971	%
Sansai	Soybean	Soybean	32.7
	Soybean	Peanuts	27.6
	Soybean	Tobacco	34.5
	Soybean	Garlic	5.2
Maetang	Soybean	Soybean	100.0
Mearim	Soybean	Soybean	100.0
Sanpatong	Soybean	Soybean	90.0
	Soybean	Peanuts	10.0

Table 29. Varieties and Price of Seeds

Location Investigated	Varieties Soybeans		Sources		Price of Seeds Baht/1kg.
Sansai	SJ 1	4	From traders and market	98	4.0
	SJ 2	84			4.9
	Mixed	12	Their own farms	2	2.5
Maetang	SJ 1	13	From trader and market	100	4.0
	SJ 2	97	Their own	0	3.5
Maerim	SJ 2	100	Traders	80	
			Their own farms	20	4.0
Sanpatong	SJ 1	12	Traders	60	2.9
	SJ 2	88	Their own farms	40	4.4

Table 30. Fertilization

Location Investigated	Type of fertilizer	Amount applied kg/rai	Time method of fertilization	Fertility of Soil			% of famers using fertilizer among investigated farms
				Fertile	Average	Barren	
Sansai	Dry cow dung	100.0 kg	After planting land that has been tilled		96	4	2%
Maetang	-	-	-		100		-
Maerim	Dry cow and pig, dung birds droppings	400.0	After planting land that has been tilled		100		45.8%
Sanpatong	Chemical fertilizer	17.5	"	12.5	82.5	6.0	1.7%
	Animal waste & straw ash	110.0	"				
	Animal waste & straw ash	195.0	"				75.0%
	Chemical fertilizer	36.7	Applied after sprouting				5.0%

Table 31. Density of Plantation (obtained by interviewing farmers)

Location Investigated	Planting time	Distance between rows	Distance betwenn hills	Volume of seeds sown per rai/kg.	No. of seed per hill	No. of plants per hill	Remar
	Month Day	(cm)	(cm)				
Sansai	Jan. 18	13.8	30.1	6.6	4.3-5.9	2.5-3.9	Drill 6 Broadc 36%
Maelang	Jan. 2	25.0	25.0	8.7	4.0-5.5	2.0-4.5	
Maerim	Jan. 12	25.0	25.0	7.8	5.0-6.5	2.0-4.5	
Sanpatong	Jan. 14	30.0	30.0	9.8	5.0-6.2	4.2-5.3	

Table 32. Density of Plantation (resulting from the actual harvesting by unit area)

Location Investigated	Planting time	Harvesting time	Distance between rows	Distance between hills	No. of plants per hill
			cm.	cm.	
Sansai	Early middle of January	April 29	40.0	31.3	2.0
Maelang	Early middle of January	April 28	36.0	35.0	2.5
Maerim	Early middle of January	April 28	34.0	31.0	2.4
Sanpatong	Early middle of January	April 27	42.0	35.5	4.8

Table 33. Farm Management

Location Investigated	Weeding			Time of weeding	Tilling			Time of tilling
	0	1st	2nd		0	1st	2nd	
Sansai	96.0	4.0	0	First month after planting	100.0	0	0	In conjunction with weeding
Maetang	100.0	0	0	Using hoe	100.0	0	0	
Maerim	100.0	0	0		100.0	0	0	
Sanpatong	97.4	1.7	0.9	2nd month after planting				
				Uwing hoe	97.4	1.7	0.9	After weeding

Table 34. Methods of Irrigation

Location Investigated	Method of Irrigation		Results of Irrigation
Sansai	Irrigate before or on planting date and twice a month afterward	%	Good
Maetant	Irrigate before or on planting date and twice a month afterward		Good
Maerim	Irrigate before or on planting date and twice a month afterward		Good
Sanpatong	Irrigate before or on planting date and 1st time afterward	0.8	
	2nd time	38.3	
	3rd time	46.7	
	4th time	13.3	
	5th time	0.8	

Table 35. Birth of Insects and Methods of Prevention

Location Investigated	Name of insects	Time of birth	Time of spraying chemical	Name of chemical	Percentage farmers us chemical
Sansai	Leaf Roller Aphids bean bugs	March-April	March-April	Malation Endres DDT. Sevin Barudrin	22.4
Maetang	-	-		-	-
Maerim	Leaf Roller bean bugs cut worm				0
Sanpatong	Leaf Roller	Feb.	Once in Feb.	Malation Endres DDT. Sevin Tloridon	

Table 36. Growth & Yield (obtained by quadrant sampling)

Location Investigated	Varieties	Percentage of mixing	Stem height cm.	No. of nodes of main stem	No. of branches per hill	Weight of stem (kg/rai)	Weight of 100 seeds gr.	Weig see (kg./
Sansai	SJ 2	3.1	35.7	10.2	3.5	106.8	11.8	19
Maetang	SJ 2	12.3	32.6	10.1	4.2	114.6	11.6	18
Maerim	SJ 2	5.6	32.5	10.5	4.5	74.8	10.2	12
Sanpatong	SJ 2	7.6	37.3	9.8	8.5	107.6	10.9	19

Chart 3. Correlation Between Weight of Seeds and Weight of Stems

c. v. = 17.10%
c. v. = 36.965%
c. v. = 37.694%

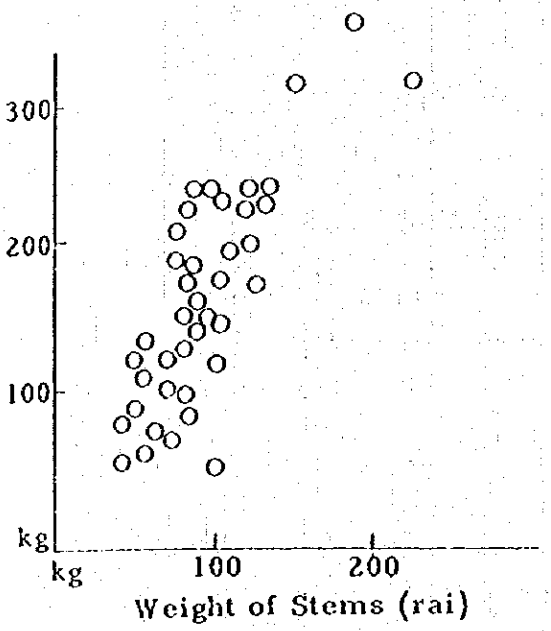


Table 37. Yield (obtained by interviewing farmers)

Location Investigated	Varieties	Weight of seeds (kg/rai)
Sansai	SJ 1	100.0
	SJ 2	161.6
	Mixed	125.0
Maetang	SJ 1	135.0
	SJ 2	177.5
Maerim	SJ 2	130.7
Sanpatong	SJ 1	135.7
	SJ 2	147.6

Table 38. Method of Reaping and Preparation of Seeds

Location Investigated	Method of reaping	Method of shelling	Method of drying	Method of grading	% of farmer grading
Saisai	Sickle	By beating with pieces of wood or bamboo	Dry in the sun	Sitting in basket	100
Maetang	Sickle	Pieces of wood	4-6 days	Sifting in basket	100
Maerim	Sickle	Pices of wood	4-7 days	Sifting in basket	100
Sanpatong	Sickle	Pices of wood	3-7 days	Sifting in basket	17.5

Table 39. Sales of Soybean

Location Investigated	Sales Price Baht/1kg.			Customer
	1969	1970	1971	
Sansai	-	2.0	2.2	Trader
Mae Tang	2.1	2.1	2.5	Trader
Mae Rim	2.1	2.1	2.2	Trader
Sanpatong	2.0	2.0	2.2	Trader

CULTIVATION IN THE RAINY SEASON 1970

QUESTIONNAIRE ON ACTUAL SOYBEAN PRODUCTION IN THAILAND

NAME OF SURVEYER _____

PLACE _____ NAME OF THE FARMER SURVEYED _____ DATE _____

MANAGED AREA OF THE FARMER INVESTIGATED

(Unit: Rai)

Name of Crop	Upland Rice	Soybean	Lowland Rice	Maize	Peanuts	Total	Remark
Area:							
Upland							
Paddy field							
Production: Volume							
Upland							
Paddy field							

1. Name of the Soybean Varieties planted A. B. C.
2. Who did you get the seeds from? A. B. C.
3. How much was the price Baht/kg. ? A. B. C.

VOLUME AND WAYS OF FERTILIZATION

Number	Name of Fertilizer	Volume Applied (kg./rai)	Time of Fertilization Day Month	Method of Fertilization (by row or just scatter)

About Fertility of the Soil (Mark with +; Explain other conditions, if any.)

Average _____ Barren _____

PLANTING METHOD AND TIME

Distance between Rows (cm.)	Distance between Hills (cm.)	Volume of Seeds Sown per rai (kg.)	Number of Seeds Sown per Hill	Number of Plants per Hill	Date of Sowing

TIME AND METHOD OF WEEDING, CULTIVATION AND SUPPLY OF WATER

	Day	Month	Day	Month	Day	Month	Day	Month
Time of Weeding								
Method of Weeding								
	Day	Month	Day	Month	Day	Month	Day	Month
Time of Cultivating								
Method of Cultivating								
Method of Water Supply								
Results of Water Supply								
Method of Draining								
Results of Draining								

KINDS OF DISEASES AND PESTS AND PROTECTION METHOD AGAINST THEM

	Name of Diseases	Time of Spraying	Name of Chemicals	Other Methods of Protection, if any, and Time
1.				
2.				
3.				
4.				

	Name of Insects	Time of Spraying	Name of Chemicals	Other Methods of Protection, if any, and Time
1.				
2.				
3.				
4.				

	Name of Varieties	Time of Harvest Month Day	Length of Stem (cm.)	Number of Pods per Plant	Yield kg./rai
1.					
2.					
3.					
4.					

ABOUT WAYS OF HARVESTING AND PREPARATION

1. Method of Reaping
2. Method of Shelling
3. Method of Drying
4. Method of Grading

ROTATION AROUND SOYBEAN

	1969						1970												1971									
1.	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
2.	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
3.	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12

MARKETING DATA

SALES VOLUME, SALES PRICES, SELF-CONSUMPTION OF SOYBEAN

Season		Sales				Self-Consumption	
		Volume Tang kg.	Bath	Satang	Types of Buyer	Tang kg.	Discription
1969	Rainy						
	Dry						
1970	Rainy						
	Dry						
1971	Rainy						
	Dry						

OPINIONS OF THE FARMERS THEMSELVES ON SOYBEAN PRODUCTION

APPENDIX 2

CULTIVATION IN THE DRY SEASON 1971

QUESTIONNAIRE ON ACTUAL SOYBEAN PRODUCTION IN THAILAND

NAME OF SURVEYER _____

PLACE _____ NAME OF THE FARMER SURVEYED _____ DATE _____

MANAGED AREA OF THE FARMER INVESTIGATED

(Unit: Rai)

Name of Crop	Upland Rice	Soybean	Lowland Rice	Maize	Peanut	Others	Total
Area:							
Upland							
Paddy field							
Production: Volume upland							
Paddy field							

		A.	B.	C.
1.	Method of Plowing	Tractor	Buffalo	Human Labour
2.	Name of the Soybean Varieties planted	A.	B.	C.
3.	Who did you get the seed from?	A.	B.	C.
4.	How much was the price Baht/kg. ?	A.	B.	C.

VOLUME AND WAYS OF FERTILIZATION

Number	Name of Fertilizer	Volume Applied (kg./rai)	Time of Fertilization Day Month	Method of Fertilization (by row or just scatter)
1.				
2.				
3.				
4.				
5.				

About Fertility of the Soil (Mark with +; Explain other conditions, if any.)

Fertile_____ Average _____ Barren _____

PLANTING METHOD AND TIME

Distance between Rows (cm.)	Distance between Hills (cm.)	Volume of Seeds Sown per Rai (kg.)	Number of Seeds Sown per Hill	Number of Plants per Hill	Date of Sowing

TIME AND METHOD OF WEEDING, CULTIVATING

	Day	Month	Day	Month	Day	Month	Day	Month
Time of Weeding								
Method of Weeding								
	Day	Month	Day	Month	Day	Month	Day	Month
Time of Cultivating								
Method of Cultivating								

KINDS OF DISEASES AND PESTS AND PROTECTION METHOD AGAINST THEM

	Name of Diseases	Time of Spraying	Name of Chemicals	Other Methods of Protection, If any, and Time
1.				
2.				
3.				
4.				

	Name of Insects	Time of Spraying	Name of Chemicals	Other Methods of Protection, if any, and Time
1.				
2.				
3.				
4.				

GROWTH AND YIELD AT THE TIME OF HARVEST

	Name of Varieties	Time of Harvest Month Day	Length of Stem (cm.)	Number of Pods per Plant	Yield kg./rai
1.					
2.					
3.					
4.					

ABOUT WAYS OF HARVESTING AND PREPARATION

1. Method of Reaping
2. Method of Shelling
3. Method of Drying
4. Method of Grading

ROTATION AROUND SOYBEAN

	1969						1970												1971											
1.	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
2.	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
3.	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12

MARKETING DATA

SALES VOLUME, SALES PRICES, SELF-CONSUMPTION OF SOYBEAN

Season		Sales				Self-Consumption	
		Volume Tang kg.	Bath	Satang	Types of Buyer	Tang kg.	Description
1969	Rainy						
	Dry						
1970	Rainy						
	Dry						
1971	Rainy						
	Dry						

OPINIONS OF THE FARMERS THEMSELVES ON SOYBEAN PRODUCTION

EXPERIMENT ON THE MAINTENANCE OF GERMINATION OF SOYBEAN SEEDS

I. Purpose

High humidity and temperature in Thailand reduce the germination percentage of soybean seeds which are placed in storage and consequently make difficult the maintenance of good varieties.

Since at present a program has been established for the purpose of increasing the scale of soybean production in this country, a method of preserving large quantities of seeds selected for promotion and of maintaining their germination percentage should be immediately found.

It is well known that the germination percentage of soybean seeds can be maintained under low atmospheric temperature. However, the hich cost involved in the setting up and maintenance of cold storage makes such a scheme prohibitive. Hence this research was conducted in order to find simple methods of maintaining the germination rates of different varieties of soybean seeds, and also to investigate the differences, if any, in their ability to retain those rates.

This study was performed by the authors with the partnership of Mr. Amnuay Tongdee. The cooperation and assistance given by the following persons are also gratefully acknowledged:- Mr. Amnuay Manitaya, Mr. Charoon Arry and Miss La-orta Vatanavasin of the Mae Jo Agricultural Experiment Station; and Mr. Senit Kittikorn and Mrs. Nida Sorajart of the Bangkhen Agricultural Experiment Station.

II. Experimental Procedure

1. Varieties Used in the Experiment

Experiment A

1) Nema-Sherizu (Japan)
2) Aki-Yoshi (Japan)
3) Shin-Mejiro (Japan)
4) Totachi-Nagaha (Japan)
5) Kogane-Jiro (Japan)
6) SJ 1 (Thailand)

7) SJ 2 (Thailand)	8) SJ 3 (Thailand)
9) SB 60 (Thailand)	10) Packchong (Thailand)
11) Taichung No. 12 (Taiwan)	12) Grant (U. S. A.)
13) 038 (small seed) (Taiwan)	14) Pai Meiton (unknown)
15) Hog Yoku (Japan)	16) Shin 4 (Japan)
17) Lincoln (U. S. A.)	18) Ohoju (Japan)
19) Bon-Minori (Japan)	20) KS 167 (Thailand)
21) Black Seed (Thailand)	21) SJ 2 (Late harvested)

22 days after maturity

Note: Countries in brackets indicate sources from which the crops were obtained.

Experiment B

SJ 2 (Thailand)

Note: Country in brackets indicates the source from which the crop was obtained.

2. Seeds Used in the Experiment

1) History

Experiment A.

The Thai and American varieties derived from dry season planting at Mae Jo Agriculture Experiment Station in 1970 and also the Japanese Varieties from planing in 1969 were used in the experiment conducted at Mae Jo Agriculture Experiment Station during the rainy season of 1970. The sowing, cultivation and planting harvesting, podding and drying processes as well as the selection of varieties were carried out under similar conditions.

Experiment B.

Seeds selected, as in Experiment A, were placed in a deier to dry at 45°C for 24 hours, after which they were immediately put into plastic bags and stored at room temperature.

2) Cultivation Process

(i) Cultivation started on July 14, 1970.

(ii) The width of the ridge was 50cm., and the blocks were spaced 20cm., apart, two plantings constituting a block.

(iii) Quantity of fertilizer: On August 4, 21 days after cultivation, N-3, P-12 and K-12 kg./rai fertilizers were applied to the plantings.

(iv) Soil characteristic: Level sandy soil.

3) Maturity and harvesting dates for varieties tested

Table 1. Maturity and Harvesting Dates for Varieties Tested

No.	Name of variety	Maturity date	Picking date	No.	Name of variety	Maturity date	Picking date
1	Nema-Shirayu	Oct. 25	Oct. 25	12	Grant	Oct. 26	Oct. 26
2	Aki-Yoshi	Oct. 20	Oct. 20	13	038 (small seed)	Oct. 26	Oct. 26
3	Shin-Mejiro	Oct. 8	Oct. 8	14	Pai Meiton	Oct. 15	Oct. 15
4	Tokachi-Nagaha	Oct. 15	Oct. 15	15	Hogyoku	Oct. 20	Oct. 20
5	Kogane-Jiro	Oct. 20	Oct. 20	16	Shin 4	Oct. 8	Oct. 8
6	SJ 1	Oct. 15	Oct. 15	17	Lincoln	Oct. 15	Oct. 15
7	SJ 2	Oct. 22	Oct. 22	18	Ohoju	Oct. 15	Oct. 15
8	SJ 3	Oct. 22	Oct. 22	19	Bon-Minori	Sep. 30	Sep. 30
9	SB-60	Oct. 29	Oct. 29	20	KS-167	Oct. 20	Oct. 20
0	Packchong	Oct. 26	Oct. 26	21	Black-seed	Oct. 26	Oct. 26
1	Taichung No. 12	Oct. 29	Oct. 29	22	SJ 2 (Late harvested)	Oct. 22	Oct. 13

4) Rainfall before and after maturity & harvesting dates

(Mae Jo Agriculture Experiment Station)

Table 2. Rainfall before and after Maturity & Harvesting Dates

Month	Day	Rainfall	No. of variety harvested	Month	Day	Rainfall mm	No. of variety harvested
Sep.	20	12.3		Oct.	19	0.2	3 5 15 20
	21	13.4			20	0	
	22	1.7			21	0	
	23	0			22	0.5	7 8
	24	12.0			23	0.6	
	25	8.0			24	0.8	
	66	0			25	0	1
	27	0			26	10.1	10 12 13
	28	0.6			27	1.2	21
	29	12.3	19		28	0	
	30	T			29	0	9 11
Oct.	1	0			30	0.6	
	2	0			31	9.5	
	3	0		Nov.	1	2.6	
	4	0			2	0	
	5	0			3	0	
	6	0			4	0	
	7	0			5	0	
	8	0	3 16		6	0	
	9	0			7	0	
	10	9.8			8	0	
	11	15.4			9	0	
	12	1.5			10	0	
	13	0			11	0	
	14	0			12	0	
	15	0	4 6 14		13	0	22
	16	1.0	17 18		14	0	
	17	0			15	0	
	18	0					

3. Equipment Used at Each Experiment Station

Experiment A

1) Bangkhen Agriculture Experiment Station
   a) Cotton bag (kept in natural temperature room)
   b) Cotton bag (kept at low temperature in air condition room)
   c) Desiccator (kept in natural temperature room)
   d) Desiccator (kept at low temperature in air conditioned room)

2) Mae Jo Agriculture Experiment Station
   a) Cotton bag (kept in natural temperature room)

Experiment started in November 1970.

Experiment B

1) Bangkhen Agriculture Experiment Station
   a) Kept at low temperature in air conditioned room.

2) Mae Jo Agriculture Experiment Station
   a) Kept in natural temperature room.

Experiment started in January 1971.

4. Germination Tests

Experiment A

1) At Bangkhen Agriculture Experiment Station, germination tests were performed by placing seeds in an incubator, the temperature being kept at 30°C during the day and 20°C at night. At Mae Jo Agriculture Experiment Station, the seeds were placed in germination trays and the temperature maintained at room temperature level. Filter papers were used in the tests at both experiment stations.

2) Three to five days after incubation, sprouting of the seedlings was observed, the length of the sprouts being about 3cm.

3) Measurements of the sprouts were taken once a month for a period of one year from November 1970 till October 1971.

As a rule, 100 seeds were used in a single test which was then repeated twice. For those varieties from which seeds were available in small number, either the testing period was extended or the number of seeds used in the test decreased. Sometimes only 50 seeds were used in the repeated tests.

Experiment B

In October 1971, ten months after the beginning of the operation at Bangkhen Agriculture Experiment Station, four tests using 100 seeds each were conducted in order to determine the percentages of sprouting. The apparatus used in these tests was the same as that used in the Experiment A and the procedure also followed that of Experiment A.

III. Experiment Results and Discussion

Maturity dates and harvesting dates of the varieties tests and the amount of rainfall before and after these periods are shown in Table 1 and 2. No obstacles in terms of weather were encountered during harvesting. The whole operation generally followed three steps, namely, harvesting, podding and preparing seeds for testing.

1. Rate of Germination

Experiment A

For cases in which the seeds were preserved naturally (using cotton bags and storing them in the natural temperature room), it may be seen by referring to Table 3, that after a period of one year, certain varieties showed virtually no decrease in germination rate, whereas in some varieties a 90 per cent reduction in germination rate was indicated. Furthermore, the varieties that showed reduced

percentages of germination comprised those whose germination rates decreased rapidly to 50 per cent after the first six months and also those whose germination rates showed a rapid decrease another six months later. The variety with the smallest reduction in germination rate was the SB 60. The Packchong, Black Seed, Pai Meiton, Taiching No. 12 and Bon Minori varieties also showed relatively small decreases in germination rate. Even after one year, they still retained 80 per cent of their germination rates. The Shin 4, Aki-Yoshi, Nema-Shirayu, Kogane-Jiro, Hogyoku and Lincoln varieties, however, retained 50 per cent of their germination rates at the end of 6 months and only 10 - 20 per cent after one year.

The SJ 1, SJ 2 and SJ 3 varieties were able to retain 80 - 90 per cent of their germination rates during the first six months but only 60 - 70 per cent after that.

Table 8 shows the moisture content in the seeds of all varieties tested. This averaged about 8.6 per cent, the variation among the varieties being negligible.

From the above observations, it can be seen that the varieties that showed relatively small decreases in germination rates were mainly the Thai ones. Certain Japanese and American varieties, on the other hand, showed appreciable reduction in germination rate.

Consequently, it may be said that high temperature and humidity constitute an unfavourable condition for the preservation of the germination rate of soybean seeds. Futhermore, the varieties which are suited to the climate of a country would depend on natural slection. An exceptional case, however, is the Bon Minori variety. Despite the fact that the majority of the Japanese varieties clearly showed reduced rates of germination, this particular variety was the only one capable of retaining a high proportion of its initial germination rate.

From this, it is clear that methods of preservation of germination rate differ from variety to variety. The factors causing this difference, however, are not yet clear. Further research on the composition of seeds and other related matters may therefore be required.

The results of the experiment conducted at Mae Jo Agriculture Experiment Station were similar to the results at Bangkhen Agriculture Experiment Station, except that the lowering of germination rate for all varieties tested at Mae Jo Agriculture Experiment Station was relatively greater (see Table 7).

As far as this discrepancy is concerned, when a comparison of the room temperatures during storage at the two experiment stations was made, it was noted that at Mae Jo Agriculture Experiment Station the minimum temperature was lower but the maximum temperature rarely higher than the respective minimum and maximum temperatures at Bangkhen Agriculture Experiment Station, the maximum temperature at Mae Jo Agriculture Experiment Station usually remaining at a low level (see Table 9).

Hence, considering temperature alone, it would appear that Mae Jo Agriculture Experiment Station offered a more favorable environment for preservation of seeds compared with that at Bangkhen Agriculture Experiment Station. The results at these experiment stations, however, indicated otherwise.

With regard to room humidity, according to Table 10, at Mae Jo Agriculture Experiment Station the minimum humidity was lower and the maximum humidity higher than the respective minimum and maximum humidities at Bangkhen Agriculture Experiment Station. In particular, at the beginning of the rainy season after the seeds had been preserved for approximately half a year, the maximum humidity at Mae Jo Agriculture Experiment Station was much higher than that at Bangkhen Agriculture Experiment Station.

Room humidity in turn reflected the rates at which the seeds absorbed moisture during storage, and from the results of the monthly survey of moisture content in the seeds (Table 11), it may be seen clearly that the percentages of moisture increased significantly, reaching 15 per cent in June.

From the above results, it may be stated that the lowering of germination rate at Mae Jo Agriculture Experiment Station was mainly due to humidity in the air, causing the moisture absorption rate of the seeds to rise, from which detrimental effects could result.

For cases in which the seeds were preserved in (b) cotton bag (kept in low temperature room), the germination rates of the seeds remained high as expected (see Table 4). However, when stored in (d) a dessicator (kept in low temperature room) and permitted entry of moisture (see Table 6), the varieties were either able to retain a high percentage of germination or exhibited negligible change in germination rate. The variety that retained high germination rate was the Kogane-Jiro and the ones that showed no appreciable changes in germination rate included the SB 60, Black seed, Packchong, SJ 1, SJ 2, KS 167, Paimeiton, Bon Minori, Grant and 038 (small seed).

By preserving the seeds at low temperature or at normal room temperature, the percentages of moisture absorption were slightly reduced, and if the seeds were preserved in a dessicator, the percentages of moisture absorption for all varieties was lowered by approximately 1 per cent.

As far as temperature is concerned, Table 9 incicates that the ranges of minimum temperature of 17°C - 24°C and maximum temperature of 20°C - 26°C permitted in the low temperature room are rather low in comparison with the ranges of temperature in the normal temperature room.

According to Table 5, when preserved in (c) a dessicator (kept in natural temperature room), certain varieties showed high rates of germination, but when preserved in (d) a dessicator (kept in low temperature room), no significant changes in germination rate within each variety were observed. These varieties included the SB 60, Black seed, Paimeiton, Grant, KS 167, Packchong, SJ 1, SJ 2, SJ 3, which are mostly Thai, and also the Bon Minori, Aki-Yoshi, Shin-Mejiro, etc, of the Japanese varieties. For other varieties, the results were inconclusive.

As may be seen in Table 9, the minimum and maximum levels of temperature in the low temperature room were both rather high and only the percentages of moisture in the seeds were equal.

From the above results, it may be deduced that within the limits of maximum and minimum temperature in the experiment, the moisture content has more influence on the germination rate than does the temperature.

In order to verify this, experiment B was also carried out.

Experiment B

The results obtained from experiment B are shown in Table 12. The merely demonstrate that the percentages of germination at the beginning of preservation and 10 months afterwards did not differ greatly. At Mae Jo Agriculture Experiment Station, a 5 per cent decrease in germination was noted, while that at the Bangkhen Agriculture Experiment Station was found to be 4 per cent.

The conditions under which the seeds were kept were similar to those described under the heading Experimental Procedure. In other works, the tests were performed in the natural temperature room at Mae Jo Agriculture Experiment Station and in the low temperature room at Bangkhen Agriculture Experiment Station. The levels of temperature during testing period were also identical to those in

experiment A as the temperature at Bangkhen Agriculture Experiment Station was lower. In this experiment, the seeds were dried and then sealed in plastic bags so as to be completely free from the influence of outside moisture. Thus if temperature had a significant effect on the maintenance of germination rate, the percentage of sprouting at Mae Jo Agriculture Experiment Station would surely decrease. This however was not the case.

Hence from these results it may be said that sufficiently high germination rate can be maintained for approximately one year if the preserved seeds had an initial misture content of 5 - 7 per cent and were subject to the temperature limitations mentioned earlier.

The results of tests on the germination rate of variety SJ 2 harvested 22 days after maturity were no different from the one harvested at maturity (see Tables 3 - 6).

2. Percentage of Hard Seeds

Concerning the percentage of hard seeds, for cases in which the moisture of seeds preserved in the dessicator decreased in percentage, it was noticed that the percentage of hard seeds increased easily, particularly when the dessicator was placed in the low temperature room. The proportion of hard seeds for the Kogane-Jiro variety was found to increase by 10.5 per cent, while the increase in other varieties more or less averaged about 1 per cent which should not be a problem.

Regarding the SJ 2 variety which was harvested 22 days after maturity, the hard seed percentage did not differ greatly from the hard seed percentage of the one harvested at maturity.

In the light of the findings from experiments A and B, the moisture content of seeds under preservation should at least be within the range of 5 - 6 per cent. By using the preservation method which allowed no entry of air, the moisture content would increase slightly

during the period of preservation as a result of absorption. The seeds would, however, retain a significantly high rate of germination even when stored at normal room temperature. When the moisture content is higher than 8 per cent, a reduction in germination rate would occur. Nevertheless, if preserved at low temperature, the seeds would be able to retain their initial rates of germination.

If the moisture content should exceed 10 per cent during preservation, the rates of germination of all varieties would decrease rapidly, with the exception of the SB 60 which is a special variety.

Lowering of the moisture content in the seeds to a level of 5 - 6 per cent by drying was a very difficult task, the lowest moisture level that was achieved being 8 - 9 per cent. However, if the seeds were dried beforehand in the dessicator and them immediately sealed in plastic bags, the moisture level in the seeds would remain 5 - 6 per cent.

Finally, considering the difference in germination rates among the varieties, it may be stated that the SB 60 is the variety with a stable rate of germination and capable of retaining its high germination percentage under various types of environment. Next are the Packchong, Black seed, Paimeiton and the Bon minori varieties which by comparison had fairly stable rates of germination.

It is considered that the results of the tests on these varieties would provide useful information when cross-breeding techniques are used for further propagation and development of new varieties.

IV. Conclusions

Generally speaking, seeds stored at low temperature were able to retain their initial germination rates for a relatively longer period. Apart from demonstrating a method of maintaining high rates of germination for soy bean seeds, this experiment also shows whether or not

certain varieties would always retain these rates. Hence they would be suitable as parent stock for further development of new varieties using cross-breeding techniques.

Commencing in July 1970, the experiment lasted until October 1971. Experiments A and B were performed at Mae Jo Agriculture Experiment Station and Bangkhen Agriculture Experiment Station.

Experiment A

1. In the case of seeds kept at natural temperature, the SB 60 variety showed a practically unaltered rate of germination after one year, while some varieties exhibited rapidly decreasing germination rates. These seeds were Paimeiton and Bon Minori and the Japanese Shin-4, Aki Yoshi, Nema-Shirazu, Kogane-Jiro and Hog Yoku.

2. The germination rate of the SB 60 variety was apparently unaffected by the conditions under which preservation was carried out. The variety would therefore be suitable as parent stock.

3. The decrease in germination rate of seeds kept in a natural temperature room appeared to be higher at Mae Jo Agriculture Experiment Station than at Bangkhen Agriculture Experiment Station. This may be explained by the fact that the maximum and minimum temperatures at Mae Jo Agriculture Experiment Station were always lower than those at Bangkehn Agriculture Experiment Station and that the humidity at Mae Jo Agriculture Experiment Station was also higher compared to the humidity at Bangkehn Agriculture Experiment Station which accounted for a 10 - 15 % increase in moisture content in the seeds, thus resulting in a decrease in germination rate.

4. Maintaining the germination rates at high levels was achieved by preserving the seeds at low temperature. Seeds stored in a

dessicator at normal temperature also retained the same high rates of germination, the average moisture content in the seeds being 7.3 per cent.

5. Based on the results of Experiments A, it may be concluded that within the range of temperature in the experiment, the moisture content in soybean seeds has a stronger influence than temperature on the maintenance of high percentage of germination.

6. With regard to variety SJ 2, seeds harvested 22 days after maturity showed the same germination rate as those harvested at full maturity.

7. As far as the proportion of hard seeds is concerned, each variety exhibited a different percentage of hard seed. The Kogane-Jiro variety showed the highest percentage of hard seeds while the majority of other varieties had approximately 1 per cent hard seeds which, of course, would pose no problem.

8. Hard seed percentage was easily increased by drying the seeds and subsequently storing them at low temperature. The hard seed percentage of the Kogane-Jiro variety, in particular, was increased three times by this process.

9. The factors causing the rate of germination to differ from variety to variety are rather interesting and will be a subject for future investigation.

Experiment B

1. When seeds were placed in sealed plastic bags with the moisture content kept at 5 - 7 per cent and stored in the natural temperature

room at Mae Jo Agriculture Experiment Station, and at low temperature at Bangkhen Agriculture Experiment Station, the rates of germination in both cases were found to be the same. Even after a period of 10 months the seeds still possessed the same rates of germination as in the beginning.

Table 3. Germination % (Bangkhen Agr. Exp. Sta.)

a) Cotton Bag (Kept in natural temperature room)

No.	Varieties	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
1	Nema-Sherayu	76.5	84.0	75.5	72.5	79.0	64.0	58.5	53.0	57.7	44.0	25.0	28.0
2	Aki-Yoshi	88.0	86.5	89.5	85.0	67.0	76.5	57.5	33.5	35.5	32.0	-	10.5
3	Shin-Mejiro	88.0	90.0	-	76.0	-	81.0	-	60.0	-	52.0	-	30.0
4	Tokachi-Nagaha	88.0	89.0	-	84.0	-	-	-	-	-	-	-	-
5	Kogane-Jiro	76.0	89.0	-	79.0	-	74.0	-	55.0	-	43.0	-	21.0
6	SJ 1	96.0	98.0	-	98.0	90.0	97.0	-	-	-	92.0	-	67.0
7	SJ 2	94.0	97.5	94.0	92.0	87.0	91.5	90.0	-	86.0	88.0	-	62.0
8	SJ 3	92.0	93.5	95.5	96.5	93.0	93.0	90.5	-	74.0	77.5	-	74.5
9	SB 60	99.0	100.0	99.0	100.0	100.0	100.0	96.0	99.0	97.0	99.0	-	96.0
10	Packchong	98.0	99.5	97.5	98.0	97.0	98.5	96.0	97.5	94.0	94.0	-	87.0
11	Taichung No. 12	94.5	97.5	95.0	96.0	97.0	96.5	97.0	94.0	92.0	88.5	-	80.5
12	Grnat	96.0	95.0	93.0	93.0	86.0	87.0	85.0	74.0	70.0	75.0	-	51.0
13	038 (small seed)	92.5	95.0	89.5	89.5	91.0	90.0	-	62.0	48.5	56.5	-	37.5
14	Pai Meiton	97.5	96.0	97.5	94.5	90.0	95.0	96.5	85.0	83.5	87.0	-	83.0
15	Hog Yoku	72.5	79.0	72.0	66.0	66.0	56.0	50.0	56.0	56.0	47.0	-	24.0
16	Shin 4	55.0	56.0	50.0	46.0	31.0	36.0	32.0	26.0	22.0	18.0	-	25.0
17	Lincoln	63.5	53.0	-	48.0	-	51.0	-	22.0	-	16.0	-	12.0
18	Ohoju	53.5	63.0	-	-	-	42.0	-	28.0	-	16.0	-	9.0
19	Bon-Minori	99.0	98.0	-	99.0	97.0	95.0	-	97.0	-	86.0	-	87.0
20	KS 167	94.0	96.0	97.0	93.0	90.0	86.0	84.0	83.0	84.0	78.0	-	53.0
21	Black Seed	95.0	100.0	-	99.0	-	98.6	-	94.0	-	90.0	-	79.0
22	SJ 2 (Late harvested)	93.0	95.5	94.5	95.0	94.5	92.5	83.5	81.5	83.5	87.0	-	78.0

Table 4. Germination % (Bangkhen Agr. Exp. Sta.)

b) Cotton Bag (Kept in low temperature room)

No.	Varieties	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
1	Nema-Sherayu	76.5	80.0	80.0	73.5	75.0	72.0	61.5	74.0	69.0	-	-	-
2	Adi-Yoshi	88.0	94.0	92.0	90.5	92.0	84.0	-	-	-	78.5	-	65.5
3	Shin-Mejiro	88.0	85.0	-	91.0	-	-	-	83.0	-	84.0	-	62.0
4	Tokachi-Nagaha	88.0	85.0	-	86.0	-	74.0	-	-	-	-	-	-
5	Kogane-Jiro	76.0	96.0	-	-	-	70.0	-	63.0	-	55.0	-	38.0
6	SJ 1	96.0	99.0	-	97.0	92.0	84.0	-	94.0	-	92.0	-	-
7	SJ 2	94.0	97.5	98.0	96.0	97.0	-	-	94.5	85.5	95.5	89.5	86.0
8	SJ 3	92.0	97.0	93.5	97.5	94.0	88.5	88.5	91.0	91.0	93.5	-	80.5
9	SB 60	99.0	98.0	100.0	99.0	97.0	100.0	100.0	99.0	99.0	95.0	98.0	96.0
10	Packchong	98.0	99.0	100.0	99.5	99.5	99.0	100.0	98.0	98.0	97.0	94.5	98.0
11	Taichung No. 12	94.5	97.0	96.0	96.0	97.5	98.0	95.0	95.5	95.5	97.5	89.0	-
12	Grant	96.0	92.0	97.0	100.0	96.0	96.0	91.0	84.0	84.0	95.0	83.0	85.0
13	038 (small seed)	92.5	94.0	94.0	94.0	91.5	88.0	-	85.5	85.5	84.0	-	86.0
14	Pai Meiton	97.5	98.5	97.5	96.0	99.0	97.5	93.5	93.0	95.0	96.5	93.0	93.5
15	Hog Yoku	92.5	78.0	79.0	80.0	79.0	78.0	74.0	-	76.0	72.0	-	-
16	Shin 4	55.0	52.0	55.0	56.0	50.0	38.0	32.0	38.0	32.0	28.0	-	-
17	Lincoln	63.5	74.0	-	-	-	62.0	-	44.0	-	-	-	37.0
18	Ohoju	53.5	62.0	-	58.0	-	42.0	-	41.0	-	42.0	-	42.0
19	Bon-Minori	99.0	98.0	-	97.0	98.0	100.0	-	98.0	-	97.0	-	-
20	KS 167	94.0	97.0	97.0	97.0	92.0	98.0	96.0	95.0	92.0	95.0	-	92.0
21	Black Seed	95.0	98.0	-	98.0	-	95.0	-	98.0	-	96.0	-	92.0
22	SJ 2 (Late harvested)	93.0	95.5	95.0	93.5	94.0	95.0	94.5	89.0	86.0	85.0	-	87.0

Table 5. Germination % (Bangkhen Agr. Exp. Sta.)

c) Dessicator (Kept in natural temperature room)

No.	Varieties	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
1	Nema-Sherayu	76.5	74.5	71.5	67.5	69.0	62.5	-	-	70.0	52.5	-	45.5
2	Aki-Yoshi	88.0	83.0	89.0	85.0	81.5	-	-	-	78.5	79.0	-	66.5
3	Shin-Mejiro	88.0	-	-	89.0	-	71.5	-	-	-	70.0	-	65.0
4	Tokachi-Nagaha	88.0	70.0	-	71.0	-	68.0	-	-	-	-	-	-
5	Kogane-Jiro	76.0	80.0	-	-	-	71.0	-	58.0	-	60.0	-	45.0
6	SJ 1	96.0	94.0	-	95.0	92.0	94.0	-	-	-	93.0	-	92.0
7	SJ 2	94.0	95.5	92.0	92.5	92.5	95.0	93.0	94.0	92.0	94.0	-	89.5
8	SJ 3	92.0	97.0	95.5	94.5	-	92.5	87.5	93.5	94.5	90.5	-	87.0
9	SB 60	99.0	99.0	96.0	99.0	99.0	96.0	98.0	94.0	97.0	93.0	99.0	95.0
10	Packchong	98.0	98.5	97.0	95.5	96.5	100.0	97.0	97.5	94.5	96.5	94.0	94.0
11	Taichung No. 12	94.5	96.0	91.5	93.5	94.5	-	96.5	92.0	96.0	95.5	-	93.5
12	Grant	96.0	93.0	96.0	97.0	91.0	94.0	90.0	91.0	89.0	92.0	86.0	92.0
13	038 (small seed)	92.5	-	92.5	94.0	-	86.5	79.0	81.5	75.5	73.0	-	75.5
14	Pai Meiton	97.5	95.0	97.0	97.0	97.5	95.5	91.0	91.5	91.0	95.5	-	92.5
15	Hog Yoku	72.5	70.0	70.0	-	-	62.0	-	64.0	-	61.0	54.0	59.0
16	Shin 4	55.0	38.0	41.0	24.0	27.0	26.0	15.0	16.0	16.0	16.0	11.0	14.0
17	Lincoln	63.0	68.0	-	42.0	-	40.0	-	38.0	-	38.0	-	47.0
18	Ohoju	53.5	-	-	-	-	40.0	-	-	-	36.0	-	19.0
19	Bon-Minori	99.0	99.0	-	98.0	100.0	96.0	-	97.0	-	97.0	-	96.0
20	KS 167	94.0	95.0	99.0	96.0	98.0	93.0	91.0	94.0	-	91.0	85.0	86.0
21	Black Seed	95.0	100.0	-	99.0	-	93.0	-	94.0	-	93.0	-	92.0
22	SJ 2 (Late harvested)	93.0	96.5	96.0	98.0	92.8	87.0	83.5	86.0	83.0	88.0	-	87.5

Table 6. Germination % (Bangkhen Agr. Exp. Sta.)

d) Dessicator (Kept on low temperature room)

No.	Varieties	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
1	Nema-Sherayu	76.5	72.0	67.5	-	69.5	71.5	68.5	64.0	66.0	59.0	57.0	63.5
2	Aki-Yoshi	88.0	-	-	88.0	88.0	89.5	85.0	-	-	87.5	79.0	71.0
3	Shin-Mejiro	88.0	-	-	89.0	-	82.0	-	82.0	-	76.0	-	67.0
4	Tokachi-Negaha	88.0	-	-	81.0	-	77.0	-	-	-	-	-	-
5	Kogane-Jiro	76.0	-	-	-	-	80.0	-	65.0	-	64.0	-	51.0
6	SJ 1	96.0	94.0	-	98.0	96.0	97.0	-	95.0	-	94.0	-	93.0
7	SJ 2	94.0	93.0	95.0	92.0	97.0	93.5	93.0	-	92.5	92.0	95.5	89.0
8	SJ 3	92.0	92.0	94.0	94.0	97.0	95.0	97.5	93.5	95.5	93.0	92.5	90.0
9	SB 60	99.0	98.0	99.0	100.0	99.0	94.0	97.0	98.0	99.0	96.0	98.0	98.0
10	Packchong	98.0	97.5	98.5	98.0	97.0	99.5	96.0	97.0	98.0	97.5	94.5	99.0
11	Taichung No. 12	94.5	96.0	96.5	96.0	93.5	98.5	96.0	95.0	99.0	-	94.5	93.5
12	Grant	96.0	94.0	93.0	96.0	100.0	99.0	92.0	97.0	91.0	91.0	9e.0	88.0
13	038 (small seed)	92.5	-	93.0	94.5	92.5	94.5	92.5	92.0	86.0	87.5	87.5	82.5
14	Pai Meiton	97.5	96.0	96.5	96.5	97.0	98.0	96.5	98.0	93.5	97.0	96.5	94.0
15	Hog Yoku	72.5	74.0	70.0	64.0	70.0	72.0	63.0	70.0	58.0	61.6	60.6	59.0
16	Shin 4	55.0	36.0	41.0	32.0	41.0	46.0	32.0	44.0	40.0	40.0	34.0	14.0
17	Lincoln	63.5	-	-	57.0	-	60.0	-	58.0	-	65.0	-	43.0
18	Ohoju	53.3	-	-	53.0	-	53.0	-	44.0	-	46.0	-	40.0
19	Bon-Minori	99.0	99.0	-	98.0	97.0	96.0	-	96.0	-	96.0	-	96.0
20	KS 167	94.0	93.0	97.5	98.0	98.0	97.0	92.0	99.0	94.0	93.0	89.0	89.0
21	Black Seed	95.0	100.0	-	97.0	-	97.0	-	98.0	-	96.0	-	91.0
22	SJ 2 (Late harvested)	93.0	96.5	94.0	91.5	92.5	94.0	91.5	92.5	-	88.0	62.5	93.5

Table 7. Germination % (Mae Jo Agr. Exp. Sta.)

a) Cotton Bag (Kept in natural temperature room)

No.	Varieties	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.
1	Hema-Sherayu	73.5	84.0	36.0	-	-	-	-	-	35.0	35.5	21.0
2	Aki-Yoshi	83.5	86.0	40.5	51.0	22.0	10.5	6.0	11.0	-	4.0	8.5
3	Shin-Mejiro	88.0	94.0	-	46.0	-	-	-	34.0	-	28.0	-
4	Tokachi-Negaha	-	-	-	-	-	-	-	-	-	-	-
5	Kogane-Jiro	88.0	91.0	-	37.0	-	32.0	-	32.0	-	-	-
6	SJ 1	94.0	97.0	92.0	78.0	80.0	75.0	72.0	74.0	-	50.0	32.0
7	SJ 2	96.0	97.5	85.0	86.0	84.5	85.0	85.5	-	83.5	85.5	49.5
8	SJ 3	92.0	96.0	96.0	97.0	88.0	81.0	74.0	62.0	-	58.0	61.0
99	SB 60	99.0	100.0	98.0	99.0	94.5	99.0	96.0	98.0	99.5	98.5	-
10	Packchong	97.0	98.0	-	95.0	-	-	-	86.0	-	-	83.0
11	Taichung No. 12	96.0	100.0	95.5	93.0	90.0	95.0	95.0	90.5	79.5	-	-
12	Grant	100.0	97.0	94.0	-	-	44.0	-	-	-	69.0	41.0
13	038 (small seed)	83.5	97.0	54.0	-	59.0	39.0	-	41.0	22.5	21.0	9.0
14	Pai Meiton	97.5	97.0	96.0	-	-	-	-	87.5	92.0	87.5	-
15	Hog Yoku	68.0	82.5	32.0	34.5	34.0	-	-	38.0	-	33.0	-
16	Shin 4	66.0	-	39.0	-	-	-	-	26.0	21.0	-	-
17	Lincoln	61.0	55.0	-	25.0	-	9.0	-	13.0	-	-	-
18	Ohoju	54.0	39.0	-	-	-	-	-	22.0	-	-	-
19	Bon-Minori	100.0	95.0	89.0	77.0	-	-	-	-	78.0	-	-
20	KS 167	98.0	96.0	97.0	89.0	82.0	74.0	74.0	76.0	74.0	51.0	21.0
21	Black Seed	99.0	99.0	-	95.0	-	88.0	-	87.0	-	81.0	-
22	SJ 2 (Late harvested)											

Table 8. Seed Moisture % of Each Variety

No.	Variety	Bangkhen Agr. Exp. Sta.				Mae Jo Agr. Exp. Sta.
		Natural temperature room		Low temperature room		Natural tem. room
		Cotton bag	Dessicator	Cotton bag	Dessicator	Cotton bag
1	Nema-Sherayu	8.8	7.3	8.3	7.3	13.7
2	Aki-Yoshi	8.6	7.3	8.0	7.2	12.5
3	Shin-Mejiro	8.7	7.2	8.3	7.3	12.3
4	Tokachi-Nagaha	8.8	7.4	8.5	7.4	-
5	Kogane-Jiro	8.7	7.2	8.2	7.3	10.5
6	SJ 1	8.7	7.2	8.2	7.3	10.5
7	SJ 2	8.4	7.3	8.2	7.3	12.3
8	SJ 3	8.5	7.3	8.1	7.2	11.9
9	SB 60	8.5	7.3	8.0	7.3	13.4
10	Packchong	8.3	7.3	8.1	7.3	11.8
11	Taichung No. 12	8.4	7.3	8.1	7.3	11.5
12	Grant	8.6	7.3	8.1	7.3	12.3
13	038 (small seed)	8.5	7.3	8.4	7.2	12.0
14	Pai Meiton	8.7	7.3	8.1	7.2	13.2
15	Hog Yoku	8.5	7.3	8.3	7.2	13.2
16	Shin 4	8.9	7.3	8.3	7.2	11.4
17	Lincoln	8.8	7.3	8.2	7.3	12.5
18	Ohoju	8.9	7.2	8.5	7.3	10.8
19	Bon-Minori	8.7	7.2	8.4	7.3	12.3
20	KS 167	8.6	7.3	8.0	7.2	12.8
21	Black Seed	8.4	7.2	8.1	7.3	13.5
22	SJ 2 (Late harvested)	8.5	7.3	8.1	7.2	-
	Average	8.6	7.3	8.2	7.3	12.1

Table 9. Temperature

Month		Bangkhen Agr. Exp. Sta.						Mae Jo Agr. Exp. Sta.					
		Natural temperature room			Low temperature room			Natural temperature room			Instrument screen shelter		
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.
November	1	29.8	26.9	28.4	92.2	77.4	18.3	-	-	-	28.5	29.1	23.8
	2	31.1	28.3	29.7	19.5	17.2	18.4	-	-	-	30.7	19.4	25.0
	3	31.2	28.6	29.9	20.4	17.4	18.9	31.5	25.6	28.6	29.4	18.7	24.1
	Aver.	30.7	27.9	29.3	19.7	17.3	18.5	31.5	25.6	28.6	29.5	19.1	24.3
December	1	29.4	27.2	28.3	21.0	19.9	20.5	26.5	23.1	24.8	27.4	20.3	23.9
	2	30.6	27.9	29.3	21.3	20.4	20.9	31.3	23.6	27.5	28.2	16.8	22.5
	3	30.7	26.8	28.8	20.7	19.6	20.2	31.2	22.1	26.7	29.2	14.8	22.2
	Aver.	30.2	27.3	28.8	21.0	20.0	20.5	29.7	22.9	26.3	28.3	17.3	22.9
January	1	27.7	22.4	25.1	19.7	18.3	19.0	26.2	16.7	21.5	25.6	10.6	17.9
	2	30.9	26.4	28.7	19.2	17.6	18.4	28.7	19.4	24.1	25.4	12.0	20.2
	3	32.0	28.0	30.0	20.5	20.5	20.5	34.0	24.4	29.2	29.7	15.3	22.5
	Aver.	30.2	25.6	27.9	19.8	18.8	19.3	29.6	20.2	24.9	26.9	12.6	20.2
February	1	31.0	26.3	28.7	21.3	20.2	20.8	31.9	25.1	28.5	28.8	14.4	21.3
	2	31.7	26.9	29.7	23.2	20.9	22.1	31.4	23.6	27.5	30.2	13.1	21.7
	3	32.9	29.1	31.0	23.3	22.0	22.7	33.6	25.1	29.4	32.5	15.2	23.9
	Aver.	31.9	27.4	29.7	22.6	21.0	21.8	32.3	24.6	28.5	30.5	44.2	22.3
March	1	33.8	29.5	31.7	26.3	22.5	24.4	35.8	27.8	31.8	34.0	18.3	26.2
	2	32.4	27.4	29.9	23.0	22.1	22.6	33.6	27.9	30.8	30.3	19.3	25.1
	3	34.2	29.7	32.0	23.6	22.6	23.1	33.0	31.1	32.3	32.8	18.4	25.7
	Aver.	33.5	28.9	31.2	24.3	22.4	23.4	34.1	29.0	31.6	32.4	18.7	25.7
April	1	35.7	30.8	33.3	25.5	24.0	24.8	34.7	27.6	31.2	34.3	18.3	26.3
	2	34.2	30.3	32.3	26.3	23.9	25.1	35.5	29.2	22.4	34.7	19.9	27.3
	3	-	-	-	25.5	23.8	24.4	35.2	29.8	32.5	34.6	21.3	28.0
	Aver.	35.0	30.6	32.8	22.4	23.9	23.2	35.1	28.9	32.0	34.5	19.8	27.2

Month		Bangkhen Agr. Exp. Sta.						Mae Jo Agr. Exp. Sta.					
		Natural temperature room			Low temperature room			Natural temperature room			Instrument screen shelter		
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.
May	1	-	-	-	-	-	-	36.6	31.3	34.0	33.6	22.1	27.9
	2	-	-	-	-	-	-	33.2	28.4	30.8	34.2	22.6	28.4
	3	-	-	-	-	-	-	34.5	27.1	30.8	34.5	22.8	28.7
	Aver.	-	-	-	-	-	-	34.8	28.9	31.9	34.1	22.5	28.3
June	1	-	-	-	-	-	-	33.4	29.5	31.5	30.3	23.4	26.9
	2	-	-	-	-	-	-	34.1	28.3	31.2	32.2	22.9	27.6
	3	-	-	-	-	-	-	30.4	25.9	28.2	31.0	33.3	27.2
	Aver.	-	-	-	-	-	-	32.6	27.9	30.3	31.2	23.2	27.2
July	1	32.1	28.8	30.5	26.4	22.8	24.6	29.7	25.8	27.8	30.7	23.0	26.9
	2	30.6	28.0	29.3	21.4	20.2	20.8	28.6	23.8	26.2	29.5	22.9	26.2
	3	30.6	27.9	29.3	23.2	20.6	21.9	28.7	25.0	26.9	29.4	23.1	26.3
	Aver.	31.1	28.2	29.7	23.7	21.2	22.5	29.0	24.9	26.9	29.9	23.0	26.5
August	1	32.0	28.5	30.3	22.5	21.0	21.8	30.6	25.6	28.1	29.1	23.2	26.2
	2	31.4	28.5	30.0	22.8	21.4	22.1	26.2	25.1	25.7	29.5	22.9	26.8
	3	31.3	28.1	29.7	23.9	22.8	24.4	27.7	23.3	25.5	29.5	24.8	27.2
	Aver.	31.6	28.4	30.0	23.1	21.7	22.4	28.2	24.7	26.4	29.4	23.6	26.3
September	1	-	-	-	-	-	-	27.8	22.8	25.3	29.7	22.9	26.3
	2	-	-	-	-	-	-	31.3	26.4	28.9	31.3	23.1	27.2
	3	-	-	-	-	-	-	30.4	24.6	27.5	31.3	22.3	26.8
	Aver.	-	-	-	-	-	-	29.8	24.6	27.2	30.8	22.8	26.8
Octover	1	-	-	-	-	-	-	30.8	24.8	27.9	30.2	22.0	26.0
	2	-	-	-	-	-	-	28.7	22.5	25.6	29.5	18.4	34.0
	3	-	-	-	-	-	-	28.4	23.2	26.8	27.2	19.9	24.5
	Aver.	-	-	-	-	-	-	29.3	23.5	26.4	29.0	20.1	24.9

Table 10. Humidity %

Month		Bangkhen Agr. Exp. Sta.						Mae Jo Agri. Exp. Sta.			
		Natural temperature room			Low temperature room			Natural temperature room			Instrument screen shelter
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Aver.
November	1	74.0	62.3	68.3	89.2	76.4	92.8	-	-	-	71.0
	2	76.0	60.4	68.2	84.1	66.1	75.1	-	-	-	71.0
	3	74.6	64.6	69.6	86.3	75.5	80.9	74.7	56.5	65.5	72.0
		75.0	62.4	68.7	86.5	72.7	79.6	74.7	56.5	65.5	71.3
December	1	85.8	70.6	78.2	89.8	80.9	85.4	86.3	74.5	80.4	82.0
	2	79.3	64.6	72.0	89.6	76.2	82.9	86.6	60.6	73.6	72.0
	3	75.6	63.5	70.0	92.2	79.0	85.6	85.4	56.9	71.2	68.0
	Aver.	80.2	66.2	73.2	90.5	78.7	84.6	86.1	64.0	75.1	74.0
January	1	70.0	54.8	62.4	80.2	70.6	75.4	73.7	54.2	64.0	65.0
	2	76.9	60.0	68.5	79.2	68.8	74.0	79.6	55.0	67.3	66.0
	3	78.3	63.7	71.0	82.6	72.4	77.5	79.0	57.5	68.3	67.0
	Aver.	75.1	59.5	77.3	80.7	70.6	75.7	77.4	55.6	66.5	66.0
February	1	73.7	57.7	65.7	78.7	69.3	74.0	78.0	55.7	66.9	67.0
	2	76.1	61.7	68.9	83.9	70.6	77.3	73.8	49.8	61.8	60.0
	3	73.6	64.8	69.2	76.7	70.3	73.5	73.4	51.0	62.2	61.0
	Aver.	74.5	61.4	68.0	79.8	70.1	75.0	75.1	52.2	63.6	62.7
March	1	76.6	60.4	68.5	81.8	69.8	75.8	75.2	52.1	63.7	64.0
	2	75.4	56.9	66.2	89.5	77.8	83.7	83.8	64.0	73.9	71.0
	3	81.3	63.0	72.2	87.7	76.8	82.3	79.7	57.3	68.5	65.0
	Aver.	77.7	60.1	68.9	86.3	74.8	80.6	79.6	57.8	68.7	66.7
April	1	75.5	62.0	68.8	83.8	71.3	77.6	72.1	49.8	61.0	56.0
	2	75.5	64.0	69.8	75.0	66.4	71.1	77.7	55.9	66.8	57.0
	3	-	-	-	-	-	-	89.5	58.8	74.2	61.0
	Aver.	-	-	-	-	-	-	79.8	54.8	67.3	58.0

Month		Bangkhen Agr. Exp. Sta.						Mae Jo Agri. Exp. Sta.			
		Natural temperature room			Low temperature room			Natural temperature room			Instrument screen shelter
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Aver.
May	1	-	-	-	-	-	-	89.4	66.0	77.7	65.0
	2	-	-	-	-	-	-	85.1	64.5	74.8	66.0
	3	-	-	-	-	-	-	95.6	65.3	80.5	75.0
	Aver.	-	-	-	-	-	-	90.0	65.3	77.7	68.7
June	1	-	-	-	-	-	-	96.9	76.9	86.9	79.0
	2	-	-	-	-	-	-	83.1	57.6	70.4	72.0
	3	-	-	-	-	-	-	96.1	75.4	85.8	77.0
	Aver.	-	-	-	-	-	-	92.0	70.0	81.0	76.0
July	1	74.4	65.1	69.8	74.9	68.2	71.6	93.1	73.8	83.5	77.0
	2	79.8	67.1	73.5	79.2	65.7	72.5	84.0	70.0	77.0	80.0
	3	76.5	66.2	71.4	77.7	67.1	72.4	96.9	76.6	86.8	79.0
	Aver.	76.9	66.1	71.5	77.3	67.0	72.2	91.3	73.5	82.4	78.7
August	1	71.3	61.8	66.6	76.1	65.9	71.0	92.4	76.0	84.2	80.0
	2	73.2	63.4	68.3	69.8	62.3	66.1	83.2	64.7	74.0	79.0
	3	74.3	66.0	70.2	64.7	55.6	60.2	83.1	73.4	83.3	79.0
	Aver.	72.9	63.7	63.7	70.2	61.3	65.8	89.6	71.4	80.5	79.3
September	1	-	-	-	-	-	-	88.4	67.4	77.9	81.0
	2	-	-	-	-	-	-	88.1	66.5	77.3	-
	3	-	-	-	-	-	-	88.1	64.1	76.0	74.0
	Aver.	-	-	-	-	-	-	88.1	66.0	77.1	77.5
October	1	-	-	-	-	-	-	91.5	69.5	80.5	74.0
	2	-	-	-	-	-	-	86.1	61.8	74.0	77.0
	3	-	-	-	-	-	-	86.5	68.1	77.3	71.0
	Aver.	-	-	-	-	-	-	88.0	66.5	77.3	74.0

Table 11. Monthly Seed Moisture %

Month	Bangkhen Agr. Exp. Sta.				Mae Jo Agr. Exp. Sta.
	Natural temperature room		Low temperature room		Natural tem. room
	Cotton bag	Dessicator	Cotton bag	Dissicator	Cotton bag
Nov.	8.0	8.0	8.0	8.0	-
Dec.	9.5	7.3	10.4	7.5	12.3
Jan.	9.3	7.3	9.0	7.2	12.2
Feb.	9.2	7.2	8.2	7.2	10.2
Mar.	8.4	7.2	9.4	7.2	10.0
Apr.	7.9	6.9	7.7	7.1	11.7
May	8.6	7.3	7.4	7.1	12.3
June	8.7	7.3	7.9	7.2	15.0
July	8.2	7.3	7.9	7.3	13.8
Aug.	8.5	7.7	7.6	7.6	11.8
Sep.	7.6	7.4	7.4	7.4	10.3
Oct.	8.6	7.0	7.0	7.0	11.5

Table 12. Results of Germination Tests

Testing Date	Mae Jo Agr. Exp. Sta.		Bangkhen Agr. Exp. Sta.	
	Germination	Seed Moistive	Germination	Seed Moistive
	%	%	%	%
Starting period	96	5.50	87	7.66
Ending period	91	8.56	83	8.41

Table 13. Hard Seed %

No.	Variety	Bangkhen Agr. Exp. Sta.				Mae Jo Agr. Exp. Sta.
		Natural temperature room		Low temperature room		Natural tem. room
		Cotton bag	Dessicator	Cotton bag	Dessicator	Cotton bag
1	Nema-Sherayu	0.25	1.16	0.73	1.64	0
2	Aki-Yoshi	0	0.13	0.09	0.23	0
3	Shi-Mejiro	1.57	1.00	1.00	2.67	0.25
4	Tokachi-Nagaha	2.67	6.00	3.67	6.67	-
5	Kogane-Jiro	3.57	11.50	7.67	10.50	4.33
6	SJ 1	0.44	1.14	0.07	0.29	0.77
7	SJ 2	1.08	1.59	1.23	1.00	0.77
8	SJ 3	0.83	0.91	1.27	1.36	0.66
9	SB 60	0.27	1.18	0.36	0.64	0.25
10	Packchong	0	0.04	0	0.13	0
11	Taichung No. 12	0.08	0.23	0.13	0.25	0.14
12	Grant	0.17	0.64	0.73	0.55	0.44
13	038 (small seed)	0.17	0.05	0.29	0.50	0.11
14	Pai Meiton	0.42	0.45	0.13	0.29	0.06
15	Hog Yoku	0.64	0.45	0.18	1.55	0.06
16	Shin 4	0.18	1.00	0.66	1.83	1.00
17	Lincoln	0	1.17	0.14	0.71	0.33
18	Ohoju	0.57	0	0.71	0	0
19	Bon-Minori	0	0	0	0.12	0
20	KS 167	0.77	0.66	0.91	1.37	0
21	Black Seed	0.14	0.50	0.28	0	0
22	SJ 2 (Late harvested)	0.167	1.59	1.55	2.00	0
	Average	0.70	1.49	0.99	1.56	0.46

RELATIONSHIP BETWEEN PLANTING TIME AND GROWTH YIELD OF SOYBEANS

I. Purpose

Soybeans have a sharp sensitivity to environmental conditions, particularly to the sunshine duration and temperature.

As shown in Table 1, the duration of sunshine in Thailand ranges from the longest of about 13 hours to the shortest of 11 hours. Though the difference is small, about two hours, soybeans show a sharp response to this small difference and present a wide gap in growth condition.

Planting at the time that promises the largest yield is one of the means adopted in soybean cultivation. However, it often happens that the planting must be carried out not at such a suitable time, particularly when soybean cultivation is incorporated in the rotation system for effective utilization of farmland or rational distribution of manpower.

In the case of Thailand, temperature does not produce adverse effects on soybean cultivation as it maintains a level higher than 10°C throughout the year except in the northern district where cool weather damage was once caused by a decline of the lowest temperature to below 10°C during the December - January period.

There are three major types of soybean cultivation in Thailand, i.e., the dry season cropping in which planting is carried out in the January - February period for harvesting in April; the wet season first cropping in which planting is conducted in the May - June period for in which planting is carried in the August - September period for harvesting in October and November. The former two types are most prevalent in Thailand. The test was conducted by establishing a number of planting times, mostly coinciding with these two cropping types, to obtain data on the growth and yield which will be required for future development of soybean cultivation.

Acknowledgement is due to Mr. Amnuay Tongdee, the Thai counterpart worker specialist in cultivation, and Mr. Choroon Aree and other staff of Mae Jo Agricultural Experiment Station who worked under the guidance of Mr. Amnuay Tongdee, for the assistance extended in the performance of the test.

II. Test Method

Test A: Dry Season Cropping (1970)

1. Test Lot

No.	Planting Date
1	December 16 (1970)
2	December 31 (1970)
3	January 15 (1971)
4	January 30 (1971)
5	February 14 (1971)

2. Test Place

Mae Jo Agricultural Experiment Station, Sandy Loam.

3. Test Variety

SJ -2

4. Planting Method

Distance between rows and hills - 50cm and 20cm, 2 plant planting.

5. Area of One Lot and Plot Design

1 lot covering an area of 15m^2 (3m x 5m); 3 replications

6. Dosage of Fertilizer Application (kg/rai)

N-3, P-12 and K-12 were applied two weeks after planting

Test B: Wet Season Cropping (1971)

1. Test Log

No.	Planting Date (SJ-2)	Planting Date (SJ-1)
1	June 1	June 1
2	June 15	June 16
3	July 1	July 1
4	July 15	July 16
5	August 1	August 1
6	August 15	August 16

2. Test Place

Mae Jo Agricultural Experiment Station; Sandy loam

3. Test Variety

SJ-2 and SJ-1

4. Planting Method

Distance between rows and hills - 50cm and 20cm, 2 plant planting.

5. Area of One Lot and Plot Design

1 lot covering an area of 15m^2, 3 replications (4 replications for SJ-1).

6. Dosage of Fertilizer Application (kg/rai)

N-3, P-12 and K-12 were applied on the 15th day after planting.

III. Test Results

Test A: Dry Season Cropping (1970)

The growing period disclosed by the test is as shown in Table 1 and Figs. 2 - 4. The later the planting date, the shorter the growing period. For example, the growing period of 105 days for planting

conducted on December 16 decreased by 15 days to 90 days for planting conducted 60 days later, i.e., on February 14. The breakdown of this reduction is as follows. While the period before flowring was somewhat extended as the planting was delayed, the fruiting period was largely reduced specially by the fourth and fifth planting. By the fifth planting, the fruiting period was cut down by 19 days, indicating that the reduction of the growing period is entirely due to the shortened fruiting period (see Fig. 4).

Since the day length increased gradually as the planting became late, the flowring period also increased, and this response to the increase in daylength is well manifested by SJ-2. This makes is quite conceivable that the fruiting period would increase for the same reason, but actually it proved to become shorter. It is considered that this phenomenon was caused by the fact that the photoperiodic response of SJ-2 by which its fruiting period tends to become longer with the increase in daylength was offset by its temperature response by which the fruiting period tends to become shorter. It is unknown which of the two response is more strongly manifested by SJ-2. In the case of the present test, however, it is considered that one of the major factors was the drought caused during the fruiting period by the shortage of soil moisture. Water supply from irrigation canals was suspended from the end of March to April to dry the soybean field while the temperature kept on rising. This is believed to have placed soybeans in droughty state and forced them into maturity, with the result that the fruiting period was shortened. In the yield factors, this should appear as an adverse effect.

The growth condition is as shown in Table 2.

As the daylength gradually increased, the flowering period was also extended, so that the main stem which should grow largely towards the end of the flowering period completed its growth before the irrigation water supply was stopped. The stem height was therefore large and showed no effect of malnutrition.

The number of branches usually increases even after the flowering time and after the stem stops growing. It should therefore increase, like the stem growth, as the planting date becomes later. In this test, however, the suspension of soil moisture supply which is indispensable for the growth of soybeans was a heavy obstacle to the growth of leaves, particularly in case of late planting, i. e., fourth and fifth. This is clear from the index of leaf area which indicates that the leaf growth was supressed in case of the third, fourth and fifth plantings.

The number of pods suggested that soybeans planted for the second and third time were supplied with a substantial amount of nutrients and produced a larger number of pods, since abseission of flowers, buds and pods arising from the shortage of soil moisture could be avoided.

The same trend is noticed in the 100 grain weight. The grain size usually becomes small if the number of pods is large. In the test, however, the second planting which was subjected to not so heavy a drought produced large grains.

The stem weight is another evidence. The second planting produced heavy steam weight.

The second and third plantings which exhibited a large vegetative growth and produced a large number of pods and large 100 grain weight attained the best yield rate. The first planting, though small in vegetative growth, was favored by sufficient soil moisture and produced a relatively large 100 grain weight, so that its yield rate was larger than the fourth and fifth plantings.

As described above, the test failed to attain its purpose of finding out what changes are brought about by different planting times to the influence of daylength and temperature on the growth and yield of soybeans, and revealed that droughty condition created by deficient soil moisture is antother important element affecting the growth and yield of this crop. Since the irrigation practices in the area around the test site are such that canal water is drained from the end of March, it was

not feasible to request water supply just because the test was conducted at an experiment station. As a result, the largest yield was shown in the second and third plantings. If sufficient soil moisture was available, however, the largest yield would naturally have been exhibited by the fourth and fifth plantings because the vegetative growth increases as the planting time becomes later and daylength consequently becomes longer.

Considering, however, the need of planting soybeans after paddy harvesting and distributing farm labor force rationally, it would not be easy to shift the planting period from January. Therefore, unless the current policy to drain the irrigation canal from the end of March is altered, the largest yield of soybeans would be obtained if planting is conducted from the end of December towards mid-January.

Fig. 1 Daylength (h)

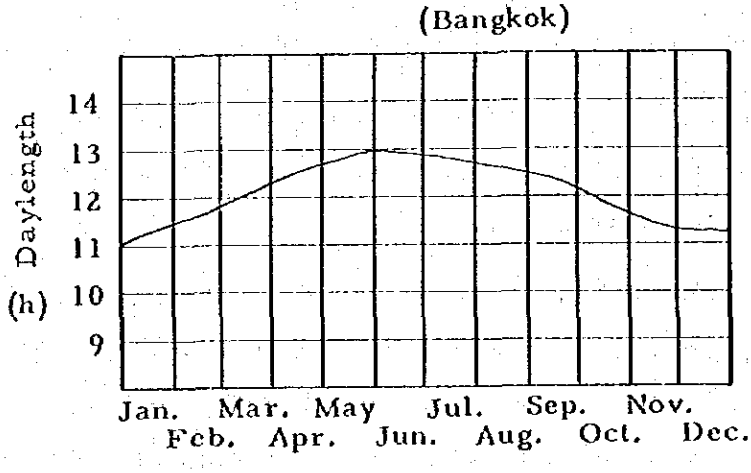


Table 1 Growing Period

No.	Planting Date	Flowering Period		Fruiting Period		Growing Period	
1	16. Dec.	42	100.0%	63	100.0%	105	100.0%
2	31. Dec.	44	104.8	55	87.3	99	94.3
3	15. Jan.	45	107.1	51	81.0	96	91.4
4	30. Jan.	44	104.8	47	74.6	91	86.7
5	14. Feb.	46	109.5	44	69.8	90	85.7

Table 2 Growth and Yield

No.	Planting Date	Time of Germinating	Time of Flowering	Time of Yellowing of Leaves	Time of Maturing	Rodging Score before Harvest	Plant Height (cm)	Number of Nodes on the Main Stem
1	16 Dec.	21 Dec.	27. Jan.	15 Mar.	31 Mar.	0	34.9 c	9.4 b
2	31 Dec.	6 Jan.	13 Feb.	28 Mar.	9 Apr.	0	48.7 b	10.0 b
3	15 Jan.	23 Jan.	1 Mar.	10 Apr.	21 Apr.	0	49.7 b	10.4 b
4	30 Jan.	5 Feb.	15 Mar.	22 Apr.	1 May	0	59.2 a	12.2 a
5	14 Feb.	20 Feb.	1 Apr.	1 May	15 May	0	53.2 a	9.4 b
C.V. %							8.02 **	8.30 *

No.	Planting Date	Number of Branches	Number of Pods	100 Grain Weight	Straw Weight (rai)	Seed Weight (rai)	Index of Leaf Area (Flowering Time)
1	16 Dec.	5.5 c	89.4 b	13.9	320.5	212.4 a	2.73
2	31 Dec.	10.4 a	122.7 a	14.7	369.7	243.4 a	2.95
3	15 Jan.	8.4	120.4 a	13.3	337.5	228.7 a	2.27
4	30 Jan.	8.3	107.1 ab	13.6	248.3	163.4 b	1.26
5	14 Feb.	5.4 c	90.4 b	13.4	217.8	143.4 b	1.44
C.V.%		** 11.73	** 9.59	N.S. 4.39		** 10.13	

Fig. 2 Relationship between Flowering Period and Fruiting Period

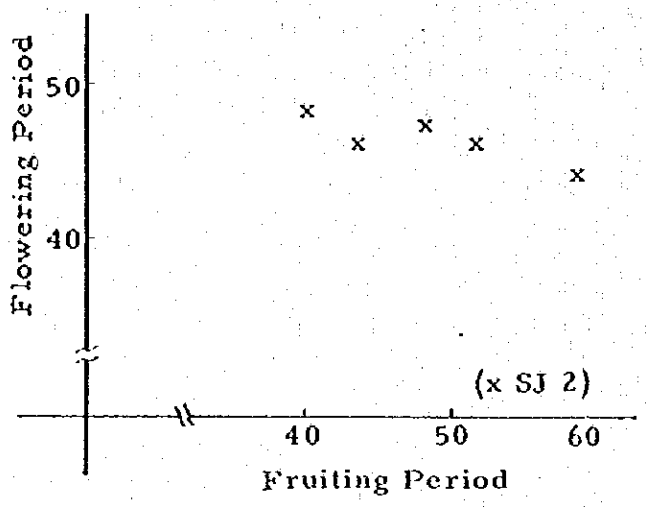


Fig. 3 Relationship between Growing Period and Flowering Period

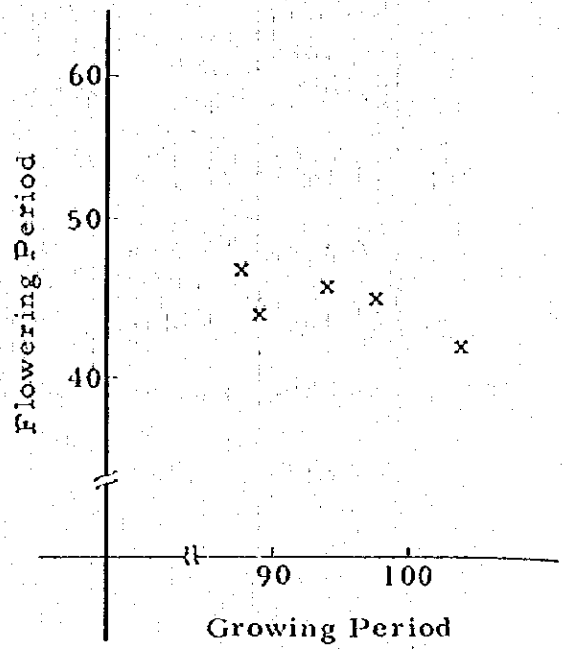
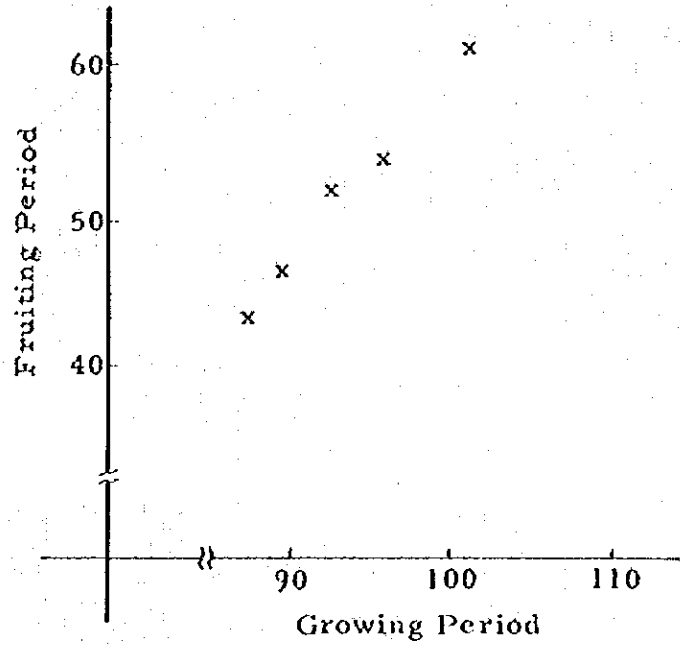


Fig. 4 Relationship between Growing Period and Fruiting Period



Test B: Wet Season Cropping (1971)

The growing period disclosed by the test is shown in Table 3 and Figs. 5 - 7.

In case of SJ-1, the growing period becomes shorter as the planting time becomes later. For instance, the growing period 106 days required for planting conducted on June 1 decreased by 30 days to 93 days for planting conducted 76 days later, i.e., on August 16. This resulted from the fact that both the flowering period and the fruiting period were reduced by approximately the same number of days.

In case of SJ-2, on the other hand, the growing period of 105 days required for planting carried out on June 1 decreased by 29 days to 94 days for planting conducted 76 days later, i.e., on August 16, showing about the same reduction in period as SJ-1. Study of the 29 day reduction reveals, however, that the flowering period did not decrease for any of the planting time and rather became a few days longer, whereas the fruiting period for all planting dates was cut down by more than ten days, thus presenting a pattern entirely different from SJ-1.

The daylength becomes gradually shorter after June and as a consequence, both the flowering period and the fruiting period usually become shorter with the delay in planting time. In case of SJ-2, however, the flowering period showed no decrease at all, from which it may be inferred that the flowering period of this variety is little or not affected by the change in daylength. But the response of the fruiting period to the daylength change is much more prominent than in the case of SJ-1. In the 1970 dry season soybean test, the flowering period showed no changes by planting time despite the fact that the test was carried out in the period when the daylength gradually becomes longer, while the fruiting period was shortened largely by drought rather than by daylenth. Consideration of these facts leads to the supposition that daylenght exerts very small influence on the flowering period of SJ-2 but its fruiting period is vulnerable to daylength and other factors. The supposition, however, must be

substantiated by future tests which must be conducted under different temperatures, daylengths, etc.

The growth condition is as shown in Tables 4 and 5.

The stem height became shorter with the delay in planting, indicating the response of soybeans to the decreasing daylenght.

This trend manifested itself in the number of nodes on the main stem and number of branches, and further exerted influence over the stem weight. The response to the daylenght change is also clear from the index of leaf area (SJ-2) which was investigated at the flowering time.

The area around the test site was inflicted by a heavy outbreak of rust which attacked soybeans seriously. The second to fourth plantings were subjected to particularly heavy rust damage. As a consequence, leaves started falling towards the end of the flowering period. The index of leaf area surveyed around this time is shown in Table 5 which clearly suggests the rapid spread of the disease.

The functional decline of soybean leaves consequent upon the rust disease invited poor assimilation, so that the 100 grain weight decreased and the grain size became extremely small, excepting the sixth planting which suffered relatively small damage. As a result, there was a marked drop in yield, particularly in case of SJ-1.

Since the 1971 test was impaired by the severe outbreak of rust, it was difficult to review the relationship between the planting time and yield. It is therefore considered advisable to refrain from making any comment on the said relationship.

The daylength decreases from June (when the first planting took place) to August, and this is considered to cause deficient vegetative growth and poor yield to August plantings. Clarification of this point will have to await next year's test for the reasons given above.

Table 3 Growing Period

(SJ - 1)

No.	Planting Date	Flowering Period		Fruiting Period		Growing Period	
			%		%		%
1	1 Jun	50	100.0	56	100.0	106	100.0
2	16 Jun.	50	100.0	52	92.2	102	96.2
3	1 July	48	96.0	47	83.9	95	89.6
4	16 July	45	90.0	49	87.5	94	88.7
5	1 Aug.	43	86.0	47	83.9	90	84.9
6	16 Aug.	41	82.0	52	92.9	93	87.7

(SJ - 2)

No.	Planting Date	Flowering Period		Fruiting Period		Growing Period	
			%		%		%
1	1 Jun.	41	100.0	64	100.0	105	100.0
2	16 Jun.	47	114.6	54	84.4	101	96.2
3	1 July	48	117.1	46	71.9	94	89.5
4	16 July	45	109.8	50	78.1	95	90.5
5	1 Aug.	44	107.3	45	70.3	89	84.8
6	16 Aug.	44	107.3	50	78.1	94.	89.5

Fig. 5 Relationship between Growing Period and Fruiting Period

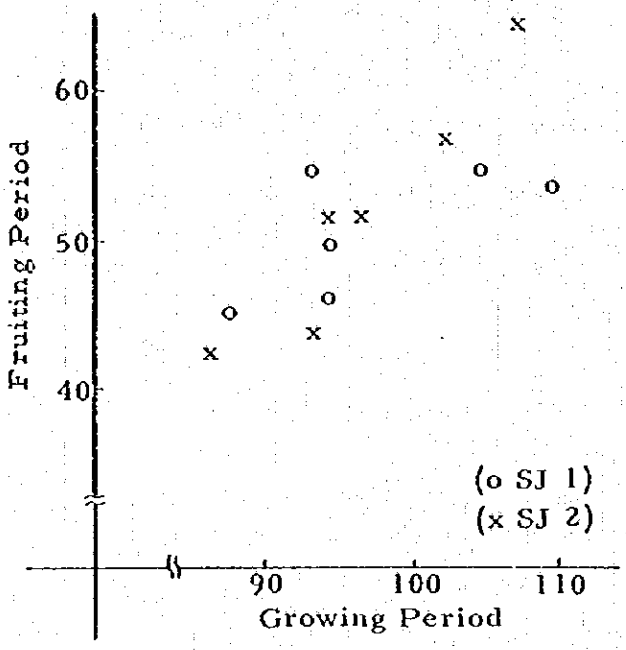


Fig. 7 Relationship between Flowering Period and Fruiting Period

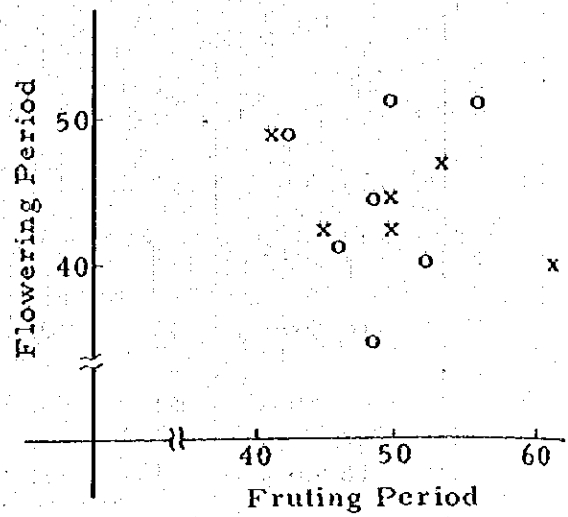


Fig. 6 Relationship between Growing Period and Flowering Period

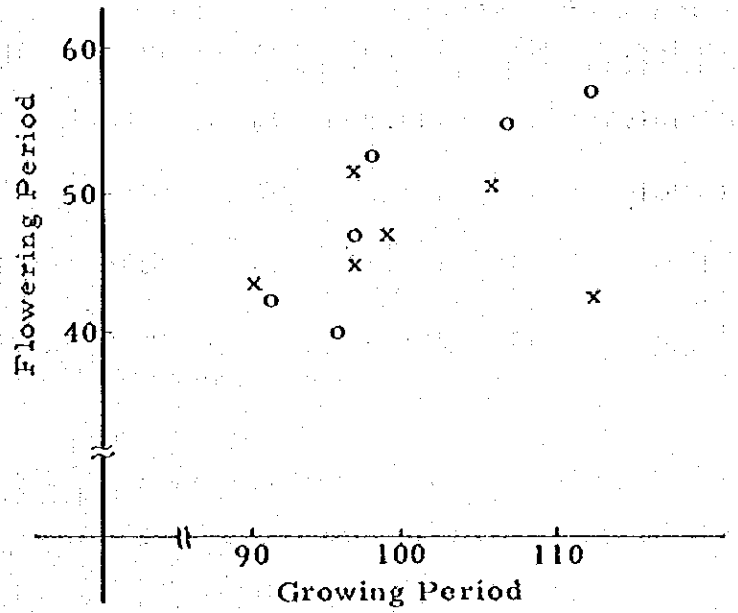


Table 4 Growth and Yield (SJ-1)

No.	Planting Date	Time of Flowering	Time of Maturing	Plant Height	Number of Nodes on the Main Stem	Number of Branches	Number of Pods	Seed Weight (rai)
				cm				
1	1 Jun.	21 July	14 Sep.	78.2 a				54.4 b
2	16 Jun.	4 Aug.	24 Sep.	77.7 a	15.4 a	10.8 a	100.2 a	54.3 b
3	1 July	17 Aug.	3 Oct.	82.3 a	14.4 a	11.3 a	77.2 b	47.0 b
4	16 July	29 Aug.	18 Oct.	40.8 b	9.9 b	6.9 b	41.0 c	21.9 c
5	1 Aug.	12 Sep.	29 Oct.	25.6 c	10.1 b	4.3 b	48.5 c	83.1 a
6	16 Aug.	25 Sep.	17 Nov.	32.9 bc	11.5 b	6.8 b	76.7 b	102.6 a
C.V. %				9.79**	8.16**	23.66**	21.14**	25.97**

Table 5 Growth and Yield (SJ-2)

No.	Planting Date	Time of Flowering	Time of Yellowing of Leaves	Time of Maturing	Rodging Score before Harvest	Plant Height	Number of Nodes on the Main Stem	Number of Branches
						cm		
1	1 Jun.	12 July	-(Rust)	14 Sep.	Small	94.4 a	16.7 a	13.3 a
2	15 Jun.	1 Aug.	-(Rust)	24 Sep.	Medium	75.3 b	16.4 a	10.1 b
3	1 July	18 Aug.	-(Rust)	3 Oct.	Small	74.0 b	16.9 a	10.0 b
4	15 July	29 Aug.	-(Rust)	18 Oct.	Small	57.3 c	13.7 b	8.9 b
5	1 Aug.	14 Sep.	20 Oct.	29 Oct.	Non	28.0 d	12.4 b	5.6 c
6	15 Aug.	28 Sep.	10 Nov.	17 Nov.	Non	30.3 c	10.3 c	6.2 c
C.V. %						6.36**	6.06**	15.74**

No.	Planting Date	Number of Pods	100 grain Weight (rai)	Straw Weight (rai)	Seed Weight (rai)	Index of Leaf Area	
						Before flowering time	After flowering time
1	1 Jun.	138.9 a	10.4 ab	163.7 a	150.3 a	3.7	2.7
2	15 Jun.	97.9 bc	7.4 c	107.8 c	90.3 c	3.3	2.7
3	1 July	118.9 ab	7.5 c	109.4 c	103.4 b	3.7	2.3
4	15 July	78.7 cd	9.7 b	131.4 b	106.7 b	1.6	0.7
5	1 Aug.	58.9 d	11.8 a	129.3 b	148.1 a	0.7	0.6
6	15 Aug.	74.7 cd	12.1 a	96.7 d	159.3 a	1.0	0.7
C. V. %		14.29**	10.38**	6.97**	5.55**		

It should be added ahta a test on the planting time for the 1971 dry season cropping is now in progress. Outline of this test is as described below:

1. Test Plot

No.	Planting Date
1	December 15
2	January 1
3	January 15
4	January 30
5	February 15

2. Test Place

Mae Jo Agricultura Experiment Station

3. Planting Density

Distance between rows and hills - 50cm and 20cm, 2 plant planting.

4. Area of One Plot and Plot Design

1 plot covering an area of 15m^2, 4 replications.

5. Dosage of Fertilizer Application (kg/rai)

Application of N-3, P-12 and K-12 on the 14th day after germinating time.

TEST ON PLANTING DENSITY

1. Purpose

It is an established fact that the assurance of a certain degree of vegetative growth cannot be dispensed with in attaining a large yield in soybean cultivation. However, the survey conducted recently on the actual state of soybean cultivation of farmers disclosed that there exist many factors which exert repressive effects on vegetative growth.

To cite an example, it was observed that the growth of dry season soybeans is suppressed by deficient soil moisture arising from poor irrigation methods and by active growth of weeds. It was felt that a step forward should be taken for improving the planting system and planting density.

In the case of the wet season cropping, it was noted that: 1) the row width varies according to whether soybeans are grown by single cropping or other crops are cultivated in the soybean field by intercropping; 2) the planting time varies largely according to the importance attached to soybeans; and 3) sparse planting density applicable to May planting is adopted even if the planting actually takes place after the May - June period. If crops other than soybeans are grown by intercropping, it is common practice to enlarge the row width but decrease the spacing in the row. However, such practice seemed to be hardly observed by farmers in general.

It was also noted that the number of seeds per hill is quite large, often exceeding ten seeds per hill, because of the germination ability of soybean seeds and the farmers' effort to make it easy for germinating seeds to shoot through the dressed soil. Consequently, it was not rare to find several plants per hill which were subjected to turion shooting, so that their stems were made thin and many of them were noticed to be lodging.

The test was conducted for the review of the planting density which was considered necessary from the observations described above.

The test was carried out mostly at Mae Jo Agricultural Experiment Station with assistance offered by Mr. Amnuay Gongdee, the Thai counterpart worker of the Department of Agriculture specializing in cultivation, and by Mr. Charoon Aree and other staff of the said experiment station who worked under the guidance of Mr. Tongdee. The team hereby expresses its deep gratitude to the valuable cooperation offered by these Thai officers.

II. Test Method

A. 1971 Dry Season Cropping

1. Test Method

Main plot : Distance between rows (cm) - 25, 50, 75
Sub-plot : Distance between hills (cm) - 15, 30, 45
Sub-sub-plot: Number of plants per hill - 1, 3, 5
Double split plot design - 4 replications

2. Planting Time

January 14, 1971

3. Test Variety

SJ-2

4. Area of One Lot

$15m^2$(3m x 5m)

5. Dosage of Fertilizer Application (kg/rai)

N-3, P-12 and K-12 applied on the 15th day after planting.

B. 1971 Wet Season Cropping

1. Test Method

Main plot : Distance between rows (cm) - 25, 50, 75
Sub-plot : Distance between hills (cm) - 15, 30, 45
Sub-sub-plot : Number of plants per hill - 1, 3, 5
Double split plot design - 3 replications

2. Planting Time

June 17, 1971

3. Test Variety

SJ-2

4. Area of One Lot

$15m^2$(3m x 5m)

5. Dosage of Fertilizer Application (kg/rai)

N-3, P-12 and K-13 applied on the 14th day after planting.

III. Test Results

A. 1971 Dry Season Crop

The germinating time was January 20, flowering time February 25 and maturing time April 26. The growth condition is as shown in Table 1.

The stem height showed an increase with the decrease in the distance between rows and hills and with the increase in the number of plants per hill. This is quite a natural phenomenon; soybeans tend to present turion shooting as the planting density becomes closer, and if this trend develops to excess, lodging occurs.

Survey of lodging score conducted at time of harvesting revealed that the highest score was shown by Lot No. 3 (distance between rows - 20cm, distance between hills - 15cm, number of plants per hill - 5) and another Lot No. 3 (distance between rows - 20cm, distance between hills - 30cm, number of plants per hill - 5), followed by Lot No. 2

(distance between rows - 20cm, distance between hills - 15cm, number of plants per hill - 3).

The number of branches per hill likewise showed an increase with the increase in the distance between rows and hills and with the increase in the number of plants per hill.

The number of nodes, on the other hand, increased with the widing of the distance between rows and hills and with the decrease in the number of plants per hill.

Accordingly, larger stem weight was observed in the lots where the stem height and number of branches were both large (i.e., lots where the distance between rows and hills was small while the number of plants per hill was large).

The number of pods per hill showed an increase with the widing of the distance between rows and hills and with the increase in the number of plants per hill, showing the maximum value in lots where the distance between rows was 75cm and the number of plants per hill was 5, or the distance between hills was 45cm and the number of plants per hill was likewise 5.

The 100 grain weight, on the other hand, showed a trend opposite to the number of pods per hill, presenting a larger value in lots where the pod number per hill is smaller. The largest 100 grain weight was observed in cases where the distance between rows was 75cm, distance between hills was 45cm and the number of plants per hill was just one.

The seed weight showed the largest value when the distance between rows was small and the number of plants per hill was 3.5.

Since the interaction between the distance between rows, distance between hills and number of plants per hill was considerably large, the highest yield was obtained from Lot No. 11 (distance between rows - 50 cm, distance between hills - 15cm, number of plants per hill - 3), followed by Lot No. 14 (distance between rows - 50cm, distance between

hills - 20cm, number of plants per hill - 3). The lowest value was observed in Lot No. 25 (distance between rows - 75cm, distance between hills - 45cm, number of plants per hill - 1) which was followed by Lot No. 16 (distance between rows - 50cm, distance between hills - 45cm, number of plants per hill - 1).

These facts indicate that when the distance between rows and hills is extremely reduced and the number of plants per hill increased, the straw weight and number of pods both increase but lodging becomes severe and the 100 grain weight decreases so that no yield increase can be expected.

It was also disclosed that when the distance between rows was set at 75cm, distance between hills at 45cm and the number of plants per hill at 1, the planting density became deficient, giving rise to lighter straw weight and smaller number of pods perhill and consequently producing only a small yield.

From the results described above, it may be said that a distance of 50cm between rows should be adopted to avoid lodging and to increase the straw weight and number of pods per hill, and that the largest yield can be expected if this distance between rows is adopted together with a distance of 15 - 30cm between hills and 3 plant planting.

Table 1. Growth and Yield

Spacing	Height of plant(cm)	Branches per hill	Number of nodes	Pods per hill	Straw weight (kg/rai)	Seed weight (kg/rai)	100 seeds gr.
A) Between 25 rows	49.2 a	5.3 c	10.2	76.4 c	499.4 a	360.9	12.9 c
50	42.2 b	6.1 b	10.7	125.9 b	329.7 b	369.8	13.1 b
75	43.2 b	7.7 a	10.8	154.2 a	278.6 c	334.3	13.9 a
	*	**	N.S.	**	**	N.S.	**
B) Between 15 plants	47.8 a	4.9 c	10.2	82.6 c	441.3 a	374.9 a	13.0 c
30	44.1 ab	6.3 b	10.9	115.7 b	348.9 b	355.1 ab	13.4 b
45	42.7 b	84. a	10.7	158.2 a	317.8 c	334.8 b	13.5 a
	*	**	N.S.	**	**	**	*
C) Plant/hill							
1	39.4 c	3.5 c	10.9 a	65.9 c	268.7 c	322.4 b	13.5 a
3	44.7 b	7.0 b	10.6 ab	120.3 b	382.6 b	373.1 a	13.3 b
5	50.3 a	9.2 a	10.2 b	170.3 a	456.4 a	369.1 a	13.0 c
	**	**	*	**	**	*	**
C.V.%	13.72	25.94	8.51	29.09	21.47	7.30	1.25
		B C	A B	A C		A B C	A B
		**	**	*		**	**
			B C	B C			A B C
			**	**			**

No.	Between (A)	Between (B)	Plants/ hill (C)	Hills cm^2	Plants/ m^2	A. B. C. ** C. V. % 7. 30	
1	20 cm	15 cm	1	33. 3	33. 3	379. 0	abcde
2	20	15	3		99. 9	377. 5	abcde
3	20	15	5		166. 5	347. 0	cdefg
4	20	30	1	16. 7	16. 7	367. 0	bcdef
5	20	30	3		50. 1	380. 5	abcd
6	20	30	5		83. 5	345. 0	cdefg
7	20	45	1	11. 1	11. 1	297. 0	hi
8	20	45	3		33. 3	388. 0	a b c
9	20	45	5		55. 5	364. 3	adefg
10	50	15	1	13. 3	13. 3	373. 5	bcde
11	50	15	3		39. 9	419. 0	a
12	50	15	5		66. 5	386. 0	a b c
13	50	30	1	6. 7	6. 7	339. 0	defg
14	50	30	3		20. 1	404. 0	a b
15	50	30	5		33. 5	378. 0	abcde
16	50	45	1	4. 4	4. 4	279. 5	i j
17	50	45	3		13. 2	367. 5	bcdef
18	50	45	5		22. 0	381. 5	abcd
19	75	15	1	8. 9	8. 9	336. 0	efgh
20	75	15	3		26. 7	370. 0	bcdef
21	75	15	5		44. 5	386. 0	a b c
22	75	30	1	4. 4	4. 4	281. 5	i j
23	75	30	3		13. 2	323. 5	g h
24	75	30	5		22. 0	377. 0	abcde
25	75	45	1	3. 0	3. 0	249. 5	j
26	75	45	3		9. 0	328. 0	fgh
27	75	45	5		15. 0	357. 5	cdefg

B. 1971 Wet Season Crop

The germinating timewas June 22, flowering time August 3, time of yellowing of leaves September 10, and maturing time October 4. For growth condition, see Table 2.

The stem height presented exactly the same trend as observed in the dry season cropping. To be precise, larger values were noticed in lots where the distance between rows was set at 25cm, and no difference in stem height was found between lots having an inter-row distance of 45cm and those having a distance of 70cm. As in the case of the dry season cropping, the height showed an increase with the narrowing of the distance between hills and the increase in the number of plants per hill.

This fact bears closely upon the lodging. In other words, the shorter the stem height, the less the lodging tendence. Lodging was limited to a small extent in lots where the one plant planting was conducted with the distance between rows set at 50cm and 75cm and that between hills at 30cm and 45cm.

The number of branches per hill decreased, as in the case of the dry season crop, with the narrowing of the distance between rows and the increase in the number of plants per hill.

The number of nodes presented a pattern approximately identical to the stem height, showing an increase with the narrowing of the distance between rows and hills and the increase in the number of plants per hill.

The straw weight, likewise showing a trend similar to that observed in the dry season crop, was larger in lots where the stem height and number of branches were both large (i.e., in lots where the distance was small both between rows and between hills and the number of plants per hill was large).

A survey of the score of leaf area conducted at the flowering time revealed that it increases with the decrease in the distance between hills

and with the increase in the number of plants per hill. The largest score observed was 4.65 attained by 5 plant planting conducted at an inter-row distance of 70cm and inter-hill distance of 15cm, which was followed by 3.75 attained by 5 plant planting conducted at an inter-row distance of 20cm and inter-hill distance of 15cm, and then by 3.26 attained by 5 plant planting conducted at an inter-row distance of 20cm and inter-hill distance of 30cm. However, the score was noticed to have dropped by about half the ordinary value in most plots due to the falling of leaves affected by rust which showed a heavy outbreak after the flowering time.

The number of pods per hill was made larger by the increase in the number of plants per hill, and presented no large difference by the distance between rows or distance between hills unlike the case of the dry season crop. This is considered attributable to heavy lodging and rust development which caused the fall of pods to disturb the test.

This same trend was noticed in the 100 grain weight. The grain size was small, and only the interaction between the distance between rows, distance between hills and number of plants per hill could be observed.

The heavy occurrence of rust described above disturbed the yield factors. As a consequence, the seed weight dropped to less than half the normal year value, and no significant differences between lots could be obtained.

The test results point to the need of another test in the next year for a study of planting density under no influence of disease development.

Table 2. Growth and Yield

Spacing	Height of plant(cm)	Branches per hill	Number of nodes	Pods per hill	Straw weight (kg/rai)	Seed weight (kg/rai)	100 seeds gr.
cm							
A) Between 25	83.3 a	10.3	15.8	106.5	170.1 a	93.0	7.0
rows 50	76.8 b	12.4	15.3	116.0	135.6 b	83.3	7.0
75	70.9 b	13.6	14.8	130.9	114.9 c	86.4	6.9
	*	N.S.	N.S.	N.S.	*	N.S.	N.S.
B) Between 15	86.4 a	10.1 c	15.6	103.6	173.0 a	93.7	7.2
plants 30	75.5 b	12.1 b	15.0	120.3	131.1 b	91.1	6.9
45	69.1 c	14.1 a	16.0	129.5	116.6 b	77.8	6.8
	**	**	N.S.	N.S.	**	N.S.	N.S.
C) Plant/hill							
1	68.2 c	6.5 c	15.5	65.7 c	117.1 c	90.4	6.8
3	76.7 b	12.1 b	14.9	114.7 b	146.0 a	88.9	6.9
5	86.1 a	17.7 a	15.6	173.1 a	157.6 a	83.3	7.1
	**	**	N.S.	**	**	N.S.	N.S.
C.V.%	10.46	27.93	7.69	38.88	21.76	31.81	13.35
	A B *		A B C *				A C **
	A C **						B C *

The plant of the test for the 1972 dry season crop is as described below.

I. Purpose

The test for the 1971 dry season crop showed, though in an approximate way, the planting density suited for soybean cultivation in Thailand. The test in 1972 will therefore be conducted for narrowing the range of planting density.

Test A:

1. Test Method

Main plot : Distance between rows (cm) - 50, 75
Sub-plot : Distance between hills (cm) - 10, 20
Sub-sub-plot: Number of plants per hill - 2, 4
Double split plot design - 3 replications

2. Planting Time

January 11, 1972

3. Test Variety

SJ-2

4. Area of One Plot

$15m^2$(3m x 5m)

5. Dosage of Fertilizer Application (kg/rai)

N-3, P-12 and K-12 to be applied on the 14th day after planting

6. Test Place

1) Mae Jo Agricultural Experiment Station

2) Huey Srithon Pilot Farm, Kalasin

Test B:

1. Test Method

Between rows (cm) - 50, 65, 80
Between hills (cm) - 20

Number of plants per hill - 2
Random block design - 4 replications

2. Planting Time

   January 1972

3. Test Variety

   SJ-2

4. Area of One Plot

   $32m^2$(4m x 8m)

5. Test Place

   Heuy Srithon Pilot Farm, Kalasin

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RELATIONSHIP BETWEEN THE TIME OF INTERTILLAGE AND MOULDING AND THE GROWTH TO YIELD OF SOYBEANS

I. Purpose

There are many means to ensure smooth growth and high yield of soybeans, and weeding is one of such means. The survey of the growth condition of soybeans grown by ordinary farm households disclosed that weeds cause considerable damage on soybean cultivation in Thailand. In the face of active growth of weeds, some farmers were noted to carry out weeding intertillage in the flower primordial or flowering period, althogh intertillage in these periods should be avoided since it is liable to damage soybean stems, leaves and particularly roots and cause flowers, buds and pods to fall. These periods coincide with the dry season when the active transpiration from stems and leaves and evaporation from soil surface are apt to reduce the soil moisture. The prevailing intertillage practice is therefore considered to exert a considerable adverse effect on the growth and yield of soybeans.

The test was conducted, partly for the purpose of demonstration to farmers, to probe into the effect of the time of intertillage and moulding.

The test was carried out with the cooperation of Mr. Amnuay Tongdee, the Thai counterpart worker of the Department of Agriculture specializing in cultivation, and also Mr. Charoon Aree and other staff of Mae Jo Agricultural Experiment Station who worked under the guidance of Mr. Tongdee. Gratitude is hereby expressed for the assistance offered by them.

II. Test Method

1. Test Plot and Time of Intertillage

No. \ Time of Intertillage and Moulding	14 days after planting (Jan. 28)	28 days after planting (Feb. 11)	42 days after planting (Feb. 25)	56 days after planting (Mar. 11)	70 days after planting (Mar. 25)	Total Number of Intertillage and Moulding
1						0
2	o					1
3	o	o				2
4	o	o	o			3
5	o	o	o	o		4
6	o	o	o	o	o	5

2. Test Variety

SJ-2

3. Planting Method

Distance between rows - 50cm, distance between hills - 20cm, number of plants per hill - 2, date of planting - January 14.

4. Area of One Plot and Plot Design

1 lot covering an area of 15 m^2(3m x 5m), 4 replications Randomized block design.

5. Dosage of Fertilizer Application (kg/rai)

N-3, P-12 and K-12 applied as base fertilizer before planting.

6. Test Place

Mae Jo Agricultural Experiment Station, Paddy field

III. Test Results

The flowering time was February 25 which falls on the 42nd day after planting and coincides with the middle of the third intertillage.

whereas the maturing time was April 26 which was the 102nd day after planting. Therefore, the fourth and fifth intertillages were carried out during the ripening period.

The growth condition of weeds in non-intertilage lot (Lot No. 1) is shown in Table 1 which indicates the wild growth of narrow leafed weeds.

The growth and yield are shown in Table 2.

The stem height tended to be shorter in the non-intertillage lot (Lot No. 1), but statistical analysis produced no significant difference. This is considered to be due to the fact that the stem growth of SJ-2 is very limited after the flowering period and the intertillage and moulding carried out after this period did not produce much adverse effect on the stem height.

The number of nodes and the number of branches per hill created no differences between lots for the same reason.

This trend was also manifested in the straw weight. It appeared that the weight in Lot No. 1 which was covered by wild growth of weeds was a little smaller than in other lots, but no significant differences were obtained by statistical analysis.

The largest number of pods was observed in Lot No. 1, and this is considered ascribable to the damage caused by weeds in Lot No. 1 and by the fall of pods in Lot Nos. 5 and 6 which was caused by the intertillage and moulding conducted in the ripening period.

The 100 grain weight was small in Lot Nos. 1, 5 and 6 where the number of pods was particularly small. It is considered likely that Lot No. 1 produced small grains by poor assimilation caused by weeds, whereas Lot Nos. 5 and 6 failed to produce large grains either because the roots were out or were damaged by intertillage.

The small 100 grain weight observed in Lot No. 2 may have resulted from the particularly large number of pods. The large grain size noticed in Plot No. 3 is considered assignable to the fact that the

intertillage and moulding work was completed before the flowering period and the growth of weeds was also limited, and these factors served to avert any physiological impediments to the growth of soybeans.

The seed weight was largest in Lot No. 3, followed by Lot No. 2. In either of these two lots, intertillage was done before the flowering period. In the lots where intertillage and moulding were conducted during the ripening period, the yield showed a decrease with the increase of frequency of intertillage and moulding but was larger than in Lot 1 where no intertillage was conducted at all.

These facts indicate that the intertillage and moulding work for weed control should be all means be completed before the flowering period. If it is conducted after the flowering period, roots are cut and develop the fall of flowers, buds and pods, and the fruiting of seeds is also marred.

During the ripening period when soybeans require lots of water, temperature is high and both atmospheric humidity and soil moisture are low. Impeding water absorption by cutting roots by weeders in this period naturally produces undesirable effects on the yield factors as clearly shown by the test results.

Table 1. Growth of Weeds in Non-intertillage Lot ($4m^2$)
(Surveyed on April 20)

Treatment	Number of Weeds			(Dry weight in gr.) Weight of Weeds		
	Narrow Leaf	Broad Leaf	Total	Narrow Leaf	Broad Leaf	Total
1	366.0	21.7	387.7	719.8	83.2	803.0

Table 2. Growth and Yield

Treatment	Height of plant(cm)	Branches per hill	Number of nodes	Pods per hill	100 seeds weight(gr.)	Straw weight ($g/4m^2$)	Seed weight (kg/rai)
1	50.8	4.0	11.2	71.7 b	12.6 c	83.4	237.1 d
2	51.5	4.4	11.3	121.6 a	13.5 b	123.5	392.0 b
3	58.3	3.9	11.2	95.3 b	14.1 a	165.0	490.1 a
4	55.6	3.9	11.6	99.9ab	14.3 a	140.0	435.0ab
5	52.1	4.0	11.9	79.9 b	13.4 b	91.5	322.0 c
6	50.2	4.2	11.7	87.0	13.3	120.2	303.0cd
C.V.%	N.S. 20.675	N.S. 29.963	N.S. 9.516	** 17.278	** 2.014	N.S. 32.678	** 12.455

Converted from $4m^2$

RELATIONSHIP BETWEEN PLANTING METHOD AND GROWTH YIELD IN SOYBEAN CULTIVATION AFTER PADDY HARVESTING

I. Purpose

The dry season soybeans are grown as the secondary cropping in irrigable paddy fields. Planting for this seconcary cropping is carried out after cutting away or burning 20 - 30 cm high paddy stubbles but without plowing the paddy fields. Since planting is conducted two to three months after paddy harvesting, paddy fields are covered with weeds to a substantial degree by this time, with some weeds having three to four true leaves.

As time goes by, therefore, weeds grow to the extent that the soybean fields look like weed fields and the growth of soybeans is largely supressed, so that it becomes impossible to expect any good yield.

It is noticed very often that soybeans are planted without plowing and water is drawn from one irrigation ditch surrounding the paddy field into two to three ditches provided within the field for flooding irrigation. There are not a few fields where such flooding irrigation inflicts wet injury on soybeans, causing poor function of the root and further producing adverse effects on the growth of stems and leaves.

Farmers seem to be well aware that plowing is good for the growth of soybeans. However, since the plowing conducted on a hired basis costs as much as B 60 per rai, plowing before planting cannot be expected to be practiced particularly because of the low yield per rai.

If the yield per rai increases, it would become possible to carry out the full-scale plowing conducted for groundnut cultivation and to carry out irrigation through ditches provided for each row instead of the prevailing flooding irrigation, thereby improving the retention of soil moisture and physical properties of soil and also retarding the growth of weeds. This method is considered quite acceptable to farmers provided that the yield is increased.

The test was conducted to study and obtain data on the points raised above.

The test was carried out with the assistance given by Mr. Amnuay Tongdee, the Thai counterpart worker of the Department of Agriculture specializing in cultivation and by Mr. Prayoon Saitum and other staff of Mae Jo Agricultural Experiment Station who worked under his guidance. Deepest gratitude is hereby expressed to these Thai workers for their valuable cooperation.

II. Test Method

1. Test Plot Formation

Main plot: A_1 - Cultivated before seedling
A_2 - Straws cut
A_3 - Straws burnt
A_4 - Cultivated before seedling and then furrowed

Sub-plot: B_1 - Hand weeding
B_2 - No weeding
B_3 - 500cc of Lasso sprayed

Split plot design, area per plot -15m^2, 3 replications

2. Planting Time

January 20, 1971

3. Test Variety

SJ-2

4. Planting Method

Distance between rows - 50cm, distance between hills - 20cm, number of plants per hill - 2.

5. Dosage of Fertilizer Application (kg/rai)

N-2, P-12 and K-12 applied before seedling

6. Test Place

Mae Jo Agricultural Experiment Station, Paddy field

III. Test Results

The growth of weeds surveyed in the flowering period is shown in Table 1. This survey revealed that all plots were uniformly covered by weeds with no significant differences between them.

However, continued observation made on the development growth made it clear that weeds in Lot A_2 (straw cut) grew earlier than in other plots, and weed development in Lot A_3 (straw burnt) occurred later than in Plot A_1 because the weed buds in this lot were burnt to death at time of burning straw. Weed development in two cultivated lots, Lot A_1 and Lot A_4, was further delayed.

It was noted that narrow leafed weeds constituted the greater part and broad leafed ones accounted for only a small portion. The number and fresh weight of the former accounted for as much as 77% and 76% of all weeds, respectively.

As for sub-plots, weed development was limited in Lot B_3 (Lasso sprayed) and heavy in Lot B_2 (no weeding).

The growth condition of soybeans is shown in Table 2. No significant differences in soybean character was noted between main plots, but in Plot A_2 (straws cut) where the weed development was earliest, the stem height and number of nodes tended to be smaller than in other plots and consequently produced the trend for ligher weight of both seeds and straw.

A soil mass measuring 30cm (D) x 30cm (W) x 10cm (T) was excavated to probe into the root system, and this disclosed that the root weight was large in cultivated lots, particularly in Lot A_4 by reason of the furrowing. Though the large root weight should have given a fabor-able effect on the growth and yield, the wild growth of weed seems to

have offset all the good effects and worked to produce no significant differences between plots.

Among the sub-plots, Plot B_1 (weeding) and Plot B_3 (herbicide applied) recorded larger than Plot B_2 (no weeding) in the stem height, number of branches, number of pods and straw weight, and also produced by far the greater yield.

It is clear from the above fact that any small time difference in weed development in the early growing period of soybeans produces no appreciable change in the quantity of weeds in the flowering period. Weed control cannot therefore be attained merely by changing the planting method. It is hoped that further studies will be for selection of suitable weeding methods including the weeding intertillage, straw mulch system practiced by some farmers after planting, and application of herbicides.

Table 1. Survey of Weeds ($1m^2$)

(Conducted on March 4, 1971)

Treatment	Number of Weeds	Weight of Weeds (fresh grass weight)
A 1	371.3	261.2 gr.
A 2	322.9	256.0
A 3	368.3	213.0
A 4	285.7	214.6
	N.S.	N.S.
B 1	94.9 b	27.9 c
B 2	702.4 a	483.7 a
B 3	213.8 b	197.0 b
	**	**
A x B	N.S.	N.S.
C.V.%	56.378	50.390

Table 2. Growth and Yield

Treatment	Height of plant	Number of Branch	Number of nodes on the main stem	Number of pods	100 grain weight(gr.)	Straw weight kg/rai	Seed weight kg/rai
A 1	51.3	6.2	10.9	93.3	11.9	163.6	277.8
A 2	43.5	4.9	10.1	85.5	11.7	109.8	232.9
A 3	46.1	5.0	10.4	93.3	11.6	127.6	248.4
A 4	49.6	4.8	10.4	93.3	11.8	145.1	243.6
	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
B 1	47.8ab	5.9 a	10.8	102.8 a	15.7	164.5a	284.5a
B 2	43.6 b	4.0 b	10.0	73.8 b	15.7	86.7b	188.7b
B 3	51.5 a	5.8 a	10.6	97.5 a	15.6	158.3a	278.8a
	**	**	N.S.	**	N.S.	*	*
A X B	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V.%	10.617	21.320	7.812	19.812	4.516	12.592	11.164

(Flowering Time 3, March. Maturing Time 18, May.)

It may be added that the test for the 1972 dry season crop is now in progress according to the following test design.

Main plot: A_1 (straws burned)

A_2 (straws cut)

A_3 (cultivated before seedling)

A_4 (cultivated before seedling, with 6kg of straw/12m2 mulched on January 1972 after planting)

A_5 (cultivated before seedling and then furrowed)

Sub-plot: B_1 (500 cc of Lasso sprayed on January 8, 1972)

B_2 (no weeding conducted)

B_3 (hand weeding conducted)

4 replications, area per lot - 12 m^2

Planting date: January 7, 1972

Planting density: Distance between rows - 50cm, distance between hills - 20cm, number of plants per hill - 3

Test variety: SJ -2

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PRODUCTION COST'S FOR THAI SOYBEAN AND PEANUT CHIENG MAI PROVINCE, DRY - SEASON

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Mae Jo Agricultural Experiment Station
Feb, 1973

INTRODUCTION

Purpose:

This report attempts to present the economics of soybean and peanut production by farmers in Chieng Mai Province. In particular, it provides an estimate of production costs, returns, and family labor, based on the results of an enquetes to the farmers, which we distrubuted, administered and collected by agricultural students of Mae Jo Agricultural College.

Procedure:

The enquete, attached to the end of this report, was translated into Thai. Based on this enquete, students and professors in the agricultural economics faculty at Mae Jo Agricultural College carried out the investigation on the farmers described in Table 1 during summer vacation 1972.

Table 1

Sample Description

Name of Amphoe	Soybean		Peanut	
	Number of Farmers	Their Total Area	Number of Farmers	Their Total Area
San patong	30	210.50 rai	30	364.50 rai
Mae Tang	15	81.00 rai	15	26.25 rai
San Sai	15	90.00 rai	15	31.75 rai
Total	60	381.50 rai	60	122.50 rai

Variety of Soybean Planted

SJ 1	43 rai
SJ 2	338.5 rai
SJ 1 : SJ 2	11.89 rai

I. Gross Return

As shown in Table 2, the unit area cultivated per farm household is smaller for peanuts than soybeans. This is because growing peanuts needs about 2.4 times as much farm investment, and 4.3 times as much family labor per rai than soybean does, as will be shown later.

Table 2

Item	Soybean	Peanut
Total Area	381.50 rai	122.50 rai
Area per Farm Household on Av.	6.35 rai	2.04 rai
Yield per Rai on Av.	8.49 rai	44.06 rai
	(127.35 kg)	(286.39 kg)
Ex-Farm Price on Av. per tang*	32.31 ฿	13.03 ฿
(per kg)	(2.15 ฿)	(2.00 ฿)
Gross Return per Rai on Av.	274.31 ฿	574.10 ฿

* The tang is the Thai unit of volume equaling 20 liters. One tang is calculated as weighing 15 kgs in case of soybeans and 6.5 kgs in case of peanut unshelled in this report. Yield and selling price of peanuts in Table 2 are those of peanuts unshelled. Weight of shelled peanuts isabout 65% of unshelled ones.

II. Cost

1. Method of Calculation

The Method of Calculating costs for each item is explained below, taking the cost of soybean seeds as an example.

A.	Total area investigated:		381.50 rai
B.	Total of cash paid by the farmers who procured seeds from outside:		6,130.00 ฿
C.	Total area of the farmers who paid cash for their seeds:		177.75 rai
D.	Av. seed cost per rai	$\frac{B}{C}$ =	34.48 ฿
E.	Total area of the farmers who self-supplied the seeds:	A - C =	203.75 ฿
F.	Ratio of the area where farmers self-supplied the seeds to the area where they paid cash for them:	E : C =	53;47
G.	Value of seed cost paid in cash in an average model of one rai:	D $\frac{47}{100} = \frac{D.C}{A}$ =	16.21 ฿
H.	Value of the self-supplied seed in the model of one rai:	D - C =	12.27 ฿

Table 3 was derived from the cost items of soybean and peanut growing demanded in the enquete and were calculated according to the above example.

One thing which can easily be noticed from the above method of calculation is that, if the same farmer partially self-supplied and partially procured seed from outside, then the whole structure of calculation would go wrong. Because of this, before starting enquete, the students were fully informed about the method of calculation. They were told to make footnotes when they came to such an example as mentioned above, and to collect the necessary added information; ie, how much was self-supplied, how much was bought.

Table 3

Soybean and Peanut Production Costs

Cost Item	Soybean					Peanut				
	Cost	Portion of Self-Supply		Portion of Pro-curement		Cost	Portion of Self-Supply		Portion of Pro-curement	
	元	元	%	元	%	元	元	%	元	%
Seed	34.48	18.27	53	16.21	47	102.29	17.01	16	89.28	84
Plowing:										
by Tractor	(68.53)	(62.36)	91	6.17	9	63.72	32.90	52	30.36	48
by Livestock	-	-		-		(35.00)	(33.95)	97	1.05	3
by Human Power	23.81	20.95	88	2.86	12	47.74	41.72	88	6.02	12
Seeding	14.58	3.79	26	10.79	74	20.60	12.44	63	8.16	37
Weeding	(8.00)	(7.60)	95	0.40	5	(15.00)	(14.76)	98	0.24	2
Cultivation	-	-		-		38.08	34.19	90	3.88	10
Harvesting	13.37	5.08	38	8.29	62	51.84	27.53	53	24.31	47
Threshing	21.45	7.72	36	13.73	64	(51.71)	(14.81)	94	0.90	6
Fertilizer:										
Compost	8.80	2.64	30	6.16	70	10.38	4.67	45	5.71	55
Chemical	(24.00)	(22.56)	94	1.44	6	-	-		-	
Treating	(2.57)	(2.54)	99	0.03	1	-	-		-	
Insecticed:										
Insecticide	(5.84)	(5.37)	92	0.47	8	(3.41)	(3.12)	92	0.29	8
Spraying	(3.55)	(3.48)	98	0.07	2	(12.00)	(11.88)	99	0.12	1
Transportation	4.48	3.74	83	0.74	17	33.13	30.02	91	3.11	9
Farm Rent	34.22	(25.67)	75	8.55	25	42.76	(34.21)	80	8.55	20
Total	155.19	79.28	51	75.91	49	414.09	232.11	56	181.98	44

In the process of tabulation it was found that the interviewers remembered these words to some extent. But it could not be hoped to have been carried out completely. As a result, the costs here

might have been estimated as somewhat lower than they really are.

2. Particulars by Item

In calculating the average cost per rai, there are certain details that should be mentioned.

A. Cost of Plowing by Tractor,

Costs of plowing tractor were handled differently in each case of soybean and peanut.

Of the total soybean area nine per cent hired tractros to plow. The other 91% of the area did not hire tractors, nor does there seem to have been hired "human power" to plow. A very crude and negligent way of cultivation is generally followed in the growing of soybeans in Chieng Mai during the dry-season. If plowing by tractor were prevalent, the yield should increase, and the whole cost-return calculation would show deffirent figures. (From the data of the Mae Jo Experiment Station, SJ 2 under complete management including plowing by tractor for seed-beds bore more than double the farmers' average yield level.) Therefore, the cost of plowing by tractor was excluded from calculation in its brackets of cost and portion of self-supply in case of soybeans. In the future, when tractor plowing has become the general process, then it will be necessary to take it as an indispensable cost, and also the yield level will naturally be higher.

In the case of peanut cultivation, the area plowed by hired tractor covers 48% of the total peanut growing area. The other 52% area was plowed by human power, although, not to the same depth of the soil as by tractor. The situation of plowing by tractor in case of peanuts is entirely different from that of soybeans; ridged seed beds are necessary to let peanuts pod inside the soil and to make the harvest easier. Usually water is inducted into the ditches among seed beds to soften the soil to make the pulling of peanut pods

from the hard laterite soil easier at harvest time. There were several examples where the same farmer hired tractor and human power at the same time for plowing in the same field, which was entirely different from the case of soybeans. It is supposed that there are some kinds of work which can not be done by hiring tractors, and those are done by human power. So, it was concluded that, for the cost of plowing for peanuts, both costs of plowing by tractor and by human power must be added together to form the whole cost of seed bed preparation for peanuts.

Plowing by livestock instead of plowing by tractor has such a small area of application (3 farmers, total area 4 rai) that it was excluded from calculation as seen in the brackets in Table 3.

B. Cost of Weeding and Intertillage,

Examples of employing labor from outside for weeding are so few, 2 farmers, 19 rai in the case of soybean and 1 farmer, 2 rai in the case of peanut, that the calculated weeding cost is very small. In addition, it was obvious from the enquetes answered that weeding is scarecely being carried out even by family labor. So, cost of weeding was excluded from cost calculation.

Weeding usually affects the result of harvest in soybean growing very much. It is a kind of field work which is easily done by family labor. Furthermore, there does not seem to exist any noteworthy industry which is able to absorb seasonal excess labor in Chieng Mai Province, nor are Chieng Mai farmers likely to go away to other areas for work. So, it was rather surprising to find out that so simple a task as weeding is not carried out in soybean growing. In the near future it is hoped that the situation will be improved greatly since the Extension Office has started extension work to promote soybean production in Norther Thailand and particularly in Chieng Mai.

Soybean did not have any examples of intertillage. But peanut had enough examples of employing laborers for intertillage, 6 farmers totalling 12.5 rai in the enquetes which exceeds 10% of the whole area. There was, moreover, more than enough evidence that the other farmers also carried out intertillage by family labor. Since intertillage belongs to the indispensable agronomic standards for growing peanuts because of the nature of bearing fruits in the soil, it is thought to be quite natural to include intertillage cost to the legitimate cost calculation for the growing of peanuts.

In the case of peanuts, weeding is included in the work of intertillage.

C. Cost of Thrashing for Peanuts,

Farmers usually sell dried unshelled peanuts to the merchants. So, the cost of shelling for peanuts was excluded from the cost calculation.

D. Cost of Fertilizer

Compost is a mix of ash from burned stalks and dried dung of chicken, pig, or cow. From the enquetes filled, 70% of the total area of soybeans and 55% of the total area of peanuts had applications of compost procured from the outside, paying cash. The remaining 30% of the total area of soybeans and 45% of the total area of peanuts were most certainly applied with self-supplied compost, because compost is usually used to cover the seeds at the time of planting, and therefore growing soybeans or peanuts without any use of compost is quite unthinkable. The cost of labor for applying the compost to the seed beds is thought to be included in the cost of seeding.

The price of compost varies depending on its quality, and the quality is very much varied and rudimental. In the cost calculation, 20 ฿ was taken for the price of one cart of compost. Generally about one half cart is applied to one rai.

As for chemical fertilizer, there were so few examples of its application (3 farmers; 23 rai) that it was excluded from the cost calculation. Its treating cost had also only two examples and was excluded from the model cost calculation too.

E. Insecticide

Very few examples of applying insecticide and fungicide to both soybeans and peanuts made their cost unsuitable to enter the cost calculation as has been explained aboutsimilar other items of cost.

F. Farm Rent,

Nineteen soybean growers and14 peanut growers rented farms as shown in Table 4. Their total area of rented farm comes up to 25% in case of soybeans and 20% in caseof peanuts of each total planted area.

Table 4

Tenure Status of Soybean and Peanut Land Included in Survey

	Soybean		Peanut	
	Number of Farm Households	Area rai	Number of Farm Households	Area rai
Owner	41	253.50	46	98.00
Owner Tenant	10	79.00 (Own 33.00) (Tenancy 46.00)	-	-
Tenant	9	49.00	14	24.50
Total	60	381.50	60	122.50

There are two very different systems of farm rent coexisting in the province. One system is to return half of the produce to the owner

as rent and the other is to pay rent in cash. The examples of the former are very few, 4 in the case of soybeans and only 1 in the case of peanuts. In the latter case, farm rent has very varied prices, ranging from ฿ 20 to ฿ 75 per rai in the case of soybeans and ฿ 20 to ฿ 100 per rai in the case of peanuts. The difference in prices may be accounted for by fertility, facility of irrigation and drainage, distance between the field and the tenants house, and so on.

It is surprising to find the old custom of contributing half of the harvest to the land owner as well as a cash payment for farm rent. Half of the harvest actually amounts to several times the payment in cash. Some explanation was given, reasoning that the landowners attend to the care of seeds, manure, etc. for 'half of the harvest'. There was not enough time to factfind the situation. Anyhow, as these soybeans and peanuts are planted as second crops to paddy, farm rent for paddy may have been mixed up to form the complication. This would be an interesting area to research in the future.

The cost of farm rent in Table 3 was obtained by dividing the tenants' total cash payment for farm rent with the corresponding total rai, excluding the area used for 'half produce'. The portions of self-supply and procurement paid in cash in the per rai cost model for the farm rent in Table 3 were calculated by proportional allotment to each total area, as done with other items of costs.

III. NET RETURN

The farmers get ฿ 198.40 per rai for soybeans and ฿ 392.12 per rai for peanuts on average as cash return for the sale of their harvest as shown in Table 5, Forty percent in case of soybean and 50% in case of peanut are the portions to be paid back for their family labour and self-supplied materials.

Table 5

Net Return Per Rai of Soybean and Peanut

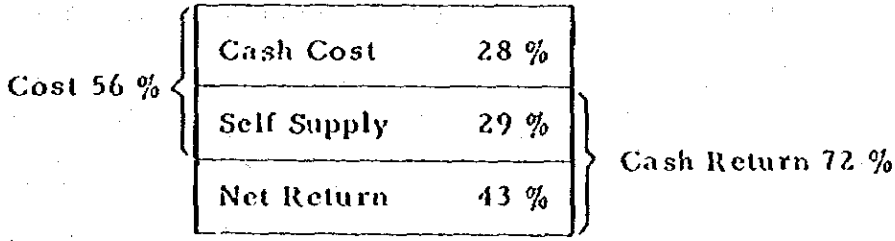
	Soybean	Peanut	Soybean : Peanut
	(฿ per rai)		
Gross Return	274.31	574.10	1 : 2.1
Cost	155.19	414.09	1 : 2.7
Self-Supply	79.28	232.11	1 : 2.9
(Family Labor)	(41.28)	(178.80)	(1 : 4.3)
(Material)	(20.91)	(21.68)	(1 : 1.0)
Cash Cost	75.91	181.98	1 : 2.4
Cash Return	198.40	392.12	1 : 2.0
Net Return	119.12	160.01	1 : 1.3

There does not seem to exist any marketing difficulties worthy of mentioning, when the farmers sell their harvest of soybeans and peanuts. Their ex-farm prices are observed to be constant for the years to date.

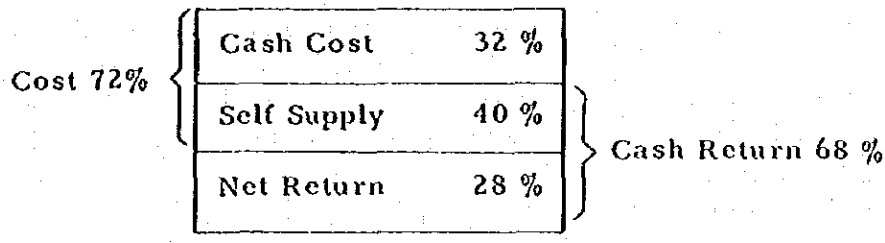
Table 6 shows the related proportions of gross returns for soybeans and peanuts.

Table 6

Soybean



Peanut



The average farmer in the area has studied an annual income as shown in Table 7 for growing dry season soybeans or peanuts during the four months, from January to April.

Table 7

Unit: ฿

	Soybean	Peanuts
Cash Income	1,260. -	800. -
Net Income	756. -	326. -

IV. OTHER DATA

1. Data on Indebtedness, Labour and Cultivation Experience

These data are summarized from the enquete as shown in Table 8. As they are very rough figures, it would be somewhat risky to infer too much from them. Nevertheless, it can generally be said that peanut cultivation is more labour intensive than soybean cultivation.

Table 8

Indebtedness, Labor and Cultivation Experience of Soybean and Peanut Farmers

	Soybean	Peanut
Number of farmers indebted	9	6
Average Amount of debt per rai	฿272	฿328
Number of farmers who got seeds in credit	6	13
Average amount of seed credit per rai	฿38.5	฿127.6
Average number of family labor per household	3.08	3.30
Average number of family labor per rai	0.48	1.61
Number of farmers who employed labor	33	28
Average number of employed labor per rai	1.09	2.68
Average years of cultivation experience	21.4	10.4

Another thing which can be noticed from the indebtedness of farmers in Table 8 is that their indebtedness remained safely within reasonable limits; that is the debt amount comes within the range of turnover of each crop. It gives significant contrast to those areas where only wet-season mono-culture is possible, and where the farmers are deep in debt with merchants, although they have the land area several times as large as those of Chiang Mai Farmers.

Note: On these points, please refer to the report on the same title of 1972 by the same writer.

2. Farmers' Hopes to Increase Production and Their Reasons

As shown in Table 9, by far the biggest reason preventing the farmers from increasing productioni is the limited land area. (From what appeared in the enquetes, they do notseem to think of increasing production by increasing that of per unit area.) Of course, this limiting factor pertains only to suburban area of Chieng Mai city, and it does not exclude the almost unlimited possibility of increasing production by increasing growing area in the other provinces like Chieng Mai, Nan and Mae Hongson etc.

Table 9

Farmers' Hopes to Increase Soybean and Production and Their Reasons

	Soybean	Peanut
Hope to increase	42	47
Does not hope to increase	17	13
No comment	1	0
Reasons		
"Positive"		
1. If he has more land	19	15
2. If he has water in his land	1	4
3. As he has spare land	1	2
4. If he has enough fertilizer	1	2
5. If he has enough family labor	-	2
6. If he has a tractor	-	1
7. If his land is not flooded	-	1
"Negative"		
1. As he has no more land	8	4
2. As he has no water in his land	1	1
3. As his land is flooded	-	3
4. As he is satisfied at the present level	2	-
5. As he must rent land to increase	-	1
6. As he has not enough family labor	-	1
7. As the labor is hard and earning is thin	-	1
"No Reasons made clear"	27	22

3. Most Needed Adjunct for Farmers at Present

Loans and credits, by far the major need in Table 10, do not necessarily mean those from the middlemen who traditionally function as money lenders, but do mean those from institutional organizations with low interest. This was shown in the report on the same title in 1972 by the present writer. In Table 10, therefore, the first item, loan, credit and the thirteenth item, low interest rate should be read in a package.

Table 10

The Needs of Soybean and Peanut Farmers

Most Needed Adjunct	Soybean	Peanut
1. Loan and credit	24	19
2. Tractor	16	25
3. Land	8	20
4. Fertilizer	9	6
5. Sprayer	7	6
6. Good and cheap seed	5	3
7. Irrigation and water	1	4
8. Livestock (baffalo, cow)	1	3
9. Water pump	1	3
10. Good price for harvest	4	-
11. Agricultural tool (hoe, spade, etc.)	-	3
12. Insecticide, Fungicide	-	2
13. Low interest for loan	-	2
14. Drainage at harvest time	-	2
15. Cultivater	-	2
16. Agricultural extension	1	-
17. Thresher	1	-

Tractors are the second most needed adjunct shown in the table. This should be understood as cheap tractoring. Owning a tractor is almost impossible, as well as not economical for an individual farmer in Thailand. Since the use of tractors is very limited; tractor is impossible during the wet season, tractors are used almost solely for

the purpose of plowing at present, and so they are used only for a very short period just before the rainy season starts in order to prepare the land for planting crops. This low operation rate of tractors is making the cost of tractoring inceasingly expensive, although the most farmers realize the tractoring is the key to increase production.

Note: In Thailand, especially in Central Plain, plowing by tractor for paddy and corn is usually undertaken by the tractoring specialists who removes in a wide range doing tractoring for the charge along the planting areas. It is sensed that only in this way of raised operation rate the tractor can be owned and kept on economic basis in this undiversified, mono-culturistic agriculture in Thailand. Agricultural tractors engaging in construction work on roads are a familar sight in this country. This is one aspect of increasing operation rate of tractors. Tractors had a vast area of activity reclaming new land at the time of maize expansion. These areas have been fast diminishing recently. In maize area, the engines of tractors are sillfully used for shelling. An invention which would make it possible for the engines to be applied to various farm management work, e. g. plowing and water pumping, would certainly be a benefit to Thai agriculture.

Usually big power tractors are needed in Thailand as the soil is laterite and very har, but small powered tractors and cultivators can also be used for more sensitive farm management work where the soil is soft and fertile like at Sawankaloke upland.

In the sense above mentioned, items 2, 5, 9, 11, 15 and 17 should be noted for further study.

4. Opinions on Agricultural Cooperatives

As Table 11 indicates, some difference of opinions was observed among the areas sueveyed. In the area where the cooperative is long established and working actively, positive opinions predominate.

Table 11

Attitudes towards Cooperatives of Soybean and Peanut Farmers

	Soybean	Peanut
Cooperative is good	39	39
Cooperative is not good	2	1
No comment	19	20
Reasons:		
"Positive answers"		
1. Because it gives loan & credit	23	24
2. Because interest rate is low	3	7
3. Because it provides for better marketing	5	2
4. Because it gives extension	2	2
5. Because one can get water facility	-	2
6. Because it is fair	1	-
7. If one has property	1	-
8. Because it gives many kinds of facilities	-	1
"Negative answers"		
1. Because it does not have any facilities	1	-
2. Because its management is bad	1	-
3. Because it is a big trouble to return money	-	1
"No comment"		
1. Because I do not like to borrow money	-	1

5. Opinions on Cooperative Seed Storage

It is clearly shonw in Table 12 that farmers' ideas about cooperative seed storage are not yet firmly established. It is probably because the marketing channels are well established.and working efficiently. Each village middleman has some storage space of his own and accumulates beans and grains to keep there from customer

farmers right after the harvest. After a short period, when they feel the price is established, they sell them readily to the merchants in towns, who, in turn, sell them to Bangkok merchants and for local consumption according to the market prices. (In this connection, please refer to the report "Marketing Channel for Thai Soybeans", H. Seto 1972).

Table 12

	Soybean	Peanut
Cooperative seed storage is good	24	24
Cooperative seed storage is not good	-	-
No comment	46	46
Reasons:		
1. Because it makes marketing advantageous	4	16
2. Because seeds can be stored	8	5
3. Because seeds for next planting season can be preserved	2	1
4. Because it will shut out middlemen	1	-
5. Because it is convenient for transportation	1	-

Another reason for the underdeveloped idea of cooperative seed storage will be found in deep-rooted individualism among Thai farmers, which, by its very nature, acts as a resistance to cooperative activities and collective management for common properties.

As for soybean seeds, it is known through practice and experiments that they generally lose viability within several months after harvest under the high moisture and hot weather conditions in Thailand. So, the soybean seeds with guaranteed germination have very high prices at each planting season. To insure the viability of the soybean seeds, Thai farmers have been continually growing soybeans through wet and dry seasons for many years within different producing areas (e.g. Chieng Mai and Sukothai) or even by setting up small individual seed plots during the off-season in their district,

so as to get the most fresh seeds possible at planting time.

It is known through experimentation that viability will be preserved completely for more than a year if seeds are kept below a certain temperature and moisture level. If seeds storage facilities which make it possible to keep seeds under such conditions can be established in producing areas, they would contribute much to the farmers' seed problem solution. Reason No. 3 in Table 12 should be understood in this sense although its mention was rate.

Note: Report on Seed Germination Experiments by Mr. H. Yarimizu, 1972

V. CONCLUSION

These tables have been extracted from the results of enquetes using a described method of calculation. It is made available for any person or organization studying Thai agriculture to draw his own conclusions.

The present writer belongs to the Thai-Japan Soybean Project and has been working to promote soybean production in this country with agronomists and breeders. His conclusions are as follows.

1. Economic Comparison between Soybeans and Peanuts Growing

As mentioned before, by the nature of the growth of the plant, growing peanuts generally gives a higher yield rate per rai than growing soybeans.

From the net return per rai calculations shown in Table 5, peanut growing gives ฿ 160 net return against soybeans ฿ 119. However, peanut growing requires 4.3 times as much family labor, 2.4 times as much cash investment and 2.7 times as much overall cost as soybean growing does. Therefore, it must be taken for granted that peanut farmers need financial assistance much more urgently than soybean farmers.

It is also concluded that peanuts is a crop more adaptable to a farmer who has limited land and much family labor. On the other hand, as soybeans is a crop which is able to bring certain net return under careless cultivation, it can be developed in the area where land is abundant and environment is similar to Chieng Mai in dry-season, but only if the farmers have good viable seeds and a minimum level of technical knowledge and experience, especially regarding germination and emergence. However, it is observed from the data that soybeans growing under the old method of "careless cultivation" has reached the limit in the suburban area of Chieng Mai city, and the leveling up of its cultivation standard has now come to the present days' programme.

2. Leveling Up of the Soybean Cultivation Standard

Soybean growing in Chieng Mai during the dry-season has been characterized by very rough and careless management and very low yield, which Japanese agronomists generally call "abandoning cultivation". It is surmised that the very favorable agronomic environment in the Chieng Mai valley and a certain level of net return guaranteed even under "abandoning cultivation method" have made its continuance possible.

As most soybean farmers want to increase production, and land increase has come to the limit as seen in Table 9, the only possible solution is to increase yield, that is, the leveling up of the cultivation standard.

It is dearly evident that if the cultivation standard is to be levelled up, the additional input must result in an output of more than the same amount, that is, the net return level must be augmented. Other wise, the farmers never feel incentives to level up their present cultivation standard.

It is shown in Tables 3 and 5, that, if tractoring is to be introduced as an indispensable agronomic standard to the present Chieng Mai level, the yield will also inevitably be increased more than 25% of the present level, otherwise, introducing tractor would have no merit. Again, if tractor, fertilizer and insecticide (fertilizer and insecticide levels are provisionally set respectively at ฿ 26.57 and ฿ 9.39 per rai here according to Table 3, although they are practically too low especially in the case of insecticide) are to be introduced, the yield increase mush be more than 38%, otherwise their merit is negligible. Moreover, it must be fully recognized that fluctuation of the price, bad weather (drought or flood), catastropic insect attack, etc. make the leveling up of the agronomic standard a risky process.

It was mentioned before that the present writer was amazed that so simple a field work as weeding is not practiced by soybean farmers in Chieng Mai province. It is clearly because they can get a certain amount of net profit without any weeding, and even if they do carry out weeding with employed labor or family labor, they feel there can not be much difference between cost and net return at their present level of technical standards and low yield. However, if a higher level of technical standard is to be introduced, the necessity of weeding will need to be emphasized.

The present writer had a survey tour visiting soybean growers in various districts and had checked fertilizer response every time he found a farmer who treated his soybeans with it. He got clear-cut positive and negative answers; each time he got a negative answer he found out that the farmer did no weeding when he treated with fertilizer.

Introducing tractor plowing not only to growing soybeans but to all upland crops is good for Chieng Mai valley agriculture,

since the operation rate of tractors will be raised, leading to lower tractor costs in the long run as mentioned in Section IV. It is very important from the viewpoint of agricultural economics to increase the use of tractors; one can then consider integrated combinations of rotation systems of paddy and upland crops and vegetables and even consider breeding crops which have special planting times or maturity needs.

During the 1973 dry season in Chieng Mai, the present writer visited the soybean fields and observed the introduction of tractor for plowing and ridging, thus, increasing the area under the guidance of the Northern Thai Extension Office. He feels that a rapid transition to higher agronomic standards is now taking place for soybean growing in Chieng Mai valley, and hopes similar steps would be taken again to enlarge upon this progress.

* * * * * * * * * * *

I express here my deep gratitude to Prof. Lusarn, Prof. Samit and their students of Mae Jo Agricultural College who took the troublesome work to question the farmers and fill the enquetes, and Prof. Sopin and his students of Kasesart University who took the troublesome work of tabulation without whose cooperation the present report could not have been completed.

Enquete on Soybean Producing Farmers

Date:

Place:

1. Area of soybean

Own.....rai Rent.....rai Total.....rai

2. Area of all his arable land

Upland:

Own.....rai Rent.....rai Total.....rai

Paddy:

Own.....rai Rent.....rai Total.....rai

3. Yield per rai or in total

per rai.....tang or.....kg

in total.....tang or.....kg

4. Selling price to middlemen

per tang ฿ ..... or per kg ฿ .....

Means of transportation.....

Transportation charge

per tang ฿ ..... or per kg ฿ .....

5. Settlement of accounts with middlemen

a. Borrowing money, how much?

b. Borrowing rice how much and repaying how much.

c. Borrowing seeds how much and repaying how much.

d. Interest rate.

e. = Other kind of borrowing for agricultural purchase and condition of repayment.

6. Total money paid for seeds ฿ .....

Name of variety

Means to keep viability if any

7. Total money paid for plowing

tractor ฿ ..... buffalo ฿ ..... human labor ฿ .....

8. Total money paid for seeding ฿ .....

   Number of persons hired

   How much payment done to each of them.

9. Total money paid for weeding ฿ .....

   Means of weeding

   Number of persons hired

   How much payment made to each of them

   Cost of herbicide when it is used

10. Total money paid for intertillage ฿ .....

    Means of intertillagd

    Number of persons hired

    How much payment made to each of them

11. Total money paid for harvesting ฿ .....

    Means of harvesting

    Number of persons hired

    How much payment made to each of them

12. Total money paid for threshing ฿ .....

    Means of threshing

    Number of persons hired

    How much payment made to each of them

    Total cost of drying if any

13. Fertilizer:

    a. Total money paid for compost ฿ .....

    b. Total money paid for chemical fertilizer ฿ .....

    c. Total money paid for the labor applying fertilizer ฿ .....

14. Pesticide:

a. Total money paid for pesticide ฿ .....

b. Total money paid for the labor of spraying ฿ .....

15. Land rent:

in total ฿ ..... per rai ฿ .....

16. a. How many family labors?

b. How many labor livestock?

c. How many temporarily hired laborers?

d. How many permanent hired laborers?

17. What kind of agricultural implements does he have?

Tractor Power Tiller Pump

Sprayer Agricultural tools and utensils and so on

18. How many years of experience in growing soybeans?

19. Farmer's opinion:

a. In increasing soybean production?

b. What is the most needed at present?

c. How about agricultural cooperatives?

d. How about establishing a cooperative storage?

* * * * * * * * * * * * * *

Note: For enquetes of peanuts, the words soybeans are changed to peanuts in the above enquetes.

EXPERIMENTS TO SELECT HERBICIDES TO CONTROL WEEDS (WITH REGARD TO SOYBEANS CULTIVATION)

I. Purpose

In order to increase the yield of soybeans grown in the dry season, it is necessary to find methods of cultivation to increase the nutrition value of the beans and to increase the weight of the stems and leaves as has been mentioned by many researchers. (This conclusion was arrived at by quadrant sampling.)

In order to do this, it is important to improve the density of plantation and to have adequate irrigation facilities. But these methods cannot eliminate one main problem, Weeds. Weeds can prevent the soybeans from developing fully, and it is regrettable that only a few farmers engage in weed control. For this reason, the soybeans leaves and stems are small, the beans do not grow as tall as possible, the number of branches and pods are limited, and all this adds up to the fact that the soybean plants are weak.

The prevention against and control of weeds consists of the process of weeding, tilling, and siding of soil. However, as soybeans are grown in rice paddies where the soil is heavy (clay loam), and the density of plantation is high (grown among the rice stubble), the distance between rows is narrow, thus making the job or weeding and tilling a laborious one. (The siding of soil also makes the soil more compact thus making it harder to weed. This is one of the reasons why most of the farmers do not engage in weeding.) (Following this, an experiment with regard to the density of plantation and the process of weeding and tilling should be made.)

At the present time, experiments are being conducted with regard to the use of chemical herbicides, and if an effective and cheap herbicide can be found, it will help greatly to increase the yield of soybeans. (This also applies to the soybeans grown in the rainy season.)

It is very important to maintain the nutrition value of soybeans grown in the dry season; however, from the actual investigation of soybean cultivation, it was learned that most of the farmers engage in weeding only once. This practice allows the weeds to grow freely thus preventing the soybeans from developing fully and making it impossible to obtain a high yield.

From now on, the process of maintenance and control should include tilling and siding of soil (to curb weeds), and on the other hand, experiments are being carried out to test various types of herbicides.

In the case of soybeans grown in the rainy season, rainfall is fairly constant thus causing the movement of the herbicides. This could result in crop damage (caused by the herbicide), and the herbicide will not be as effective in killing weeds as in the dry season.

Therefore it is necessary to test the various types of herbicides under various conditions (wet, dry, etc.) so as to make a comparison of the herbicides.

In selecting the herbicide, one must not only take into consideration its effectiveness with regard to growth, yield and efficiency to kill weeds, but one must also find a herbicide that will not be dangerous to fishes.

This investigation was carried out with the cooperation of Mr. Amnuay Tongdee, my counterpart, who is responsible for cultivation (Dept. of Agriculture), and Mr. Charoon Arry of the Mae Jo Agriculture Experiment Station. I wish to take this opportunity to thank both of these gentlemen.

II. Methods of Experiment

1. Experiments on Cultivation of Soybeans in the Dry Season of 1971

Experiment A. Experiment A

1. Types of Herbicide, experiment area

No.	Kinds of Herbicide	(Component)	Amount used per rai
1	Lasso (Solution)	43.7%	500cc (Product)
2	Lasso (Granule)	10.0	2.5kg (Product)
3	Lorox (Solution)	50.0	200g (Component)
4	Swepp (Solution)	40.0	500g (Product)
5	Swepp (Granule)	15.0	2.0kg (Product)
6	Mo. 338 (Solution)	20.0	320cc (Product)
7	Treflan (Emulsion)	44.5	200cc (Component)
8	Planavin (Solution)	75.0	100g (Component)
9	Atrazin (Solution)	50.0	200g (Product)
10	Telvar (Monuron) (Solution)	80.0	200g (Product)
11	Cottoran (Solution)	80.0	240g (Component)
12	Herban (Solution)	-	200g (Product)
13	2,4 - D (Solution)	70.3	150cc (Component)
14	Hand weeding	-	-
15	No weeding	-	-

Note: Spraying of herbicide immediately after planting. Solution and Emulsion: Area:- 45m^2 Dilute herbicide with 6,000 ccs of water, then spray.

2. Location of Experiment: Mae Jo Agriculture Experiment Station

3. Soil Conditions: PH 6.1% organic matter-0.56 Sandy loam; percentage of moisture in the soil at time of spraying = 88%

4. Planting done on January 7th

5. Type of Seed used: SJ 2

6. Planting: distance between row-50cm, hill - 20cm

7. Planted Area: 1 Section: 1 section = 15m , ground turned over 3 times

8. Spraying done on January 8th

9. Amount of fertilizer used: N-3, P-12, K-12 kg/rai

10. Survey of weeds done on the 42nd day after planting (February 18th)

Experiment B

1. Type of herbicide used, experiment area

No.	Kinds of Herbicide	(Component)	Amount used per rai
1	Lasso (Solution)	43.7%	400cc (Product)
2	Lasso (Solution)	43.7	300cc (Product)
3	Lorox (Solution)	50.0	300g (Component)
4	Lorox (Solution)	50.0	100g (Component)
5	Swepp (Solution)	40.0	600g (Product)
6	Swepp (Solution)	40.0	400g (Product)
7	Swepp (Granule)	15.0	3kg (Product)
8	Swepp (Granule)	15.0	1kg (Product)
9	Mo. 338 (Solution)	20.0	200cc (Component)
10	Mo. 338 (Solution)	20.0	100cc (Component)
11	Treflm (Emulsion)	44.5	150cc (Component)
12	Treflm (Emulsion)	44.5	100cc (Component)
13	Planavin (Solution)	75.0	150g (Component)
14	Planavin (Solution)	75.0	50g (Component)
15	Telvar (Solution)	80.0	150g (Product)
16	Telvar (Solution)	80.0	100g (Product)

2. Planting done on January 12th

3. Planted Area: Section : Section : (= $4m^2$)

4. No fertilizers used

5. Spraying done on January 12th

6. Survey of weeds done on the 38th day after planting (February 19th)

Everything else the same as Experiment A.

2. Experiments on Cultivation of Soybeans in the Rainy Season of 1971

Experiment A

1. Type of herbicide used, experiment area

No.	Kinds of Herbicide	(Component)	Amount used per rai
1	Lasso (Solution)	43.7%	500 cc
2	Lasso (Granule)	10.0	2.5 kg
3	Lorox (Solution)	50.0	200 g
4	Swepp (Solution)	40.0	500 g
5	Swepp (Granule)	15.0	2 kg
6	Mo. 338 (Solution)	20.0	320 cc
7	Treflan (Emulsion)	44.5	200 cc
8	Planavin (Solution)	75.0	150 g
9	Gesagard (Solution)	-	160 g
10	Cottoran (Solution)	80.0	200 g
11	Herban (Solution)	-	200 g
12	Igran (Solution)	-	230 g
13	Hand weeding	-	-
14	No weeding	-	-

Note: Spraying of herbicide immediately after planting. Solution and emulsion: area: $45m^2$; dilute with 6,000 ccs of water, then spray.

2. Location of experiment: Mae Jo Agriculture Experiment Station

3. Soil Conditions: PH. 6.1% organic matter 0.31 sandy loam

4. Planting done on July 22

5. Type of seeds used: SJ 2

6. Planting: Distance between row 50cm, hill 20cm. 5 seeds per hill

7. Planted area: 1 section (=15m^2) ground is turned aover 3 times

8. Spraying done on July 23rd

9. No fertilizers used

10. Survey of weeds done on the 41st day after planting. (September 1st)

Experiment B

1. Type of herbicide used, experiment area

No.	Kinds of Herbicide	Component	Amount used per rai
1	Lorox (Solution)	50.0%	150 g
2	Lorox (Solution)	50.0	100 g
3	Swepp (Solution)	40.0	400 g
4	Swepp (Solution)	40.0	300 g
5	Mo. 338 (Solution)	20.0	200 cc
6	Mo. 338 (Solution)	20.0	100 cc
7	Terflan (Emulsion)	44.6	150 cc
8	Treflan (Emulsion)	44.6	100 cc
9	Planavin (Solution)	75.0	75 g
10	Planavin (Solution)	75.0	50 g

No.	Kinds of Herbicide	Component	Amount used per rai
11	Swepp (Granule)	15.0%	1.5 kg
12	Swepp (Granule)	15.0	1.0 kg
13	Gesagard (Solution)	-	120 g
14	Gesagard (Solution)	-	80 g
15	Herban (Solution)	-	175 g
16	Herban (Solution)	-	150 g
17	Cottoran (Solution)	80.0	200 g
18	Cottoran (Solution)	80.0	150 g
19	Igran (Solution)	-	200 g
20	Igran (Solution)	-	150 g

2. Planted area: 1 section (= $4m^2$)

Everything else the same as Experiment A.

III. Results of the Experiments

(1) Experiments on Cultivation of Soybeans in the Dry Season of 1971

The experiments were carried out on a sandy loam type of soil, and it can be said the there is a high movement of herbicide. (This is dangerous for germination and future development of soybeans.) As there was no rainfall at all, it was necessary to irrigate the land from time to time so as to keep the moisture in the soil at a stable level. At the time of spraying, the temperature was relatively high, thus reducing the efficiency of some types of herbicide to kill weeds. Some herbicides poisoned the soybeans at an accelerated pace because of the heat. What floows are the results of the experiments on each type of herbicide tested:

1) Lasso (Solution)

This type presents no dangers on the rate og germination and does not adversely affect the growth and yield of the soybeans.

Weeds will appear 20 days after spraying. Lasso can kill both narrow and broad types of weeds. This type should be used as a standard for selecting more efficient herbicides. However the high cost will make it difficult to persuade the farmers to use it.

2) Lasso (Granule)

This is as effective as the solution, but if irrigation is carried out while the chemical has not completely dissolved, the chemical will wash away with the water, thus making the killing of weeds uneven.

3) Lorox (Solution)

This type does not affect the rate of germination (same as lasso), but after germination, the plants will die if there is too much or too little moisture in the soil. Also, the chemical will limit the growth of the beans, the stems will weightless, and the yield will be smaller - about 100-300 g. per rai. We cannot say that this type is beneficial.

4) Sweep (Solution)

The rate of germination is the same as above, and there is no withering after germination. Weeds grow faster than with lasso, especially the narrow type. (Cannot curb narrow type very well.) The yield is no different than in the case of hand weeding (standard). Amount used: 500 g per rai, and when the temperature is high, the weed killing efficiency of the chemical is reduced.

5) Sweep (Granule)

Water from the irrigation process will wash the chemical to low ground and the beans in the area will wither and die.

The chemical is not effective in curbing the narrow type, and narrow weeds grow much faster than in the case of lasso.

6) Mo. 338 (Solution)

The effect on germination is the same as lasso and others, and there is no withering after germination. Weeds grow slowly - same as lasso - and the development and yield of beans is normal. This herbicide is very stable, and the amount used totalled 200 - 400 g (product) per rai. (Experiments should be made with regard to various type of soil.)

7) Treflan (Solution)

Effect on germination is the same as other types, and there is no big problem with withering after germination. The yield is normal, about 150 -200 g (component) per rai. This type is not too effective in controlling the broad type of weeds.

8) Planavin (Solution)

Effect on germination is the same as other types, and some hills wither and die after germination. Weeds grow at the same rate as with Mo. 338 and there is some effect on growth, and there is a tendency towards a lower yield. Amount used totalled 100 g per rai, and there was little growth of weeds.

It is necessary to experiment with 60 - 70 g (component).

9) Atrazine (Solution)

Effect on germination is the same as other types, but after germination, the chemical will be a great danger to the crop and most of the plants will die. This is very effective in curbing weeds, but at a greatly reduced yield. This product is not used.

10) Telvar (Solution)

Many hills will wither and die after germination and the growth and yield of the crop is limited. This is very effective for controlling weeds, only 100 - 151 g (product) used but the chemical is not used.

11) Cottoran (Solution)

Same as telvar; should not be used.

12) Herban (Solution)

Effect on germination is the same as other types, and effect on growth and yield after germination is also the same. This product gives good results, but weeds grow faster than in the cases of lasso hand Mo. 338. Amount used totalled 200 g (product) per rai.

13) 2. 4 - D (Solution)

It is a known fact that this chemical is not a suitable herbicide in the case of soybeans but is mentioned only as a reference. (Experiment also carried out.) From experience, it can be said that the rate of germination is clearly low, and the growth and yield is also low. It is not suggested that this type of chemical be used in any form.

(2) Experiments on Cultivation of Soybeans in the Rainy Season of 1971

The experiments carried out with regard to the soybeans grown in the dry season were done in paddy fields, - soybeans as a second crop - but the experiments in the rainy season were carried out in soybeans plantations. Even though the soil was a sandy loam, the organic matter contained in the soil was only 0.21%, whereas the

Table 1 - Rate og Germination, Rate of Death after Germination

No.	Kinds of Herbicide	Germination %	% of damage after germination(against % of germination)	Conditions of Crop Failure
1	Lasso (Solution)	42.5 a	0	
2	Lasso (Solution)	47.5 a	0	
3	Lorox (Solution)	52.5 a	13.0	If there is too much moisture in the soil, the beans will die after germination due to the herbicide.
4	Swepp (Solution)	51.7 a	0	
5	Swepp (Granule)	60.8 a	19.0	Due to the lack of water, the herbicide will settle on low ground and could easily destroy the crop.
6	Mo338 (Solution)	56.7 a	0	
7	Tefflan (Emulsion)	51.7 a	0.7	
8	Planavin (Solution)	53.3 a	4.0	
9	Atrazine (Solution)	49.2 a	86.7	After germination, the beans will wither and die because of the herbicide.
10	Telvar (Solution)	57.5 a	68.3	If there is too much moisture, the beans will wither.
11	Cottoran (Solution)	52.5 a	40.3	After germination, the beans will wither at the time the simple leaves begin to unfurl.
12	Herban (Solution)	51.8 a	0	
13	2,4-D (Solution)	30.8 b	0	The beans will not grow.
14	Hand weeding	47.5 a	-	
15	No weeding	52.5 a	-	
	C.V.(%)	9.147	Investigation carried out on 18th Feb.	

Note: Before germination 14th Jan.

Table 2 - Study of Weeds (1m^2 investigated on 18th Feb.)

No.	Kinds of herbicide	Weed number		Weed Weight		Time of Sprouting of Weeds
		Narrow	Broad	Narrow	Broad	
		%	%	%	%	
1	Lasso (S)	0	0	0.3	0	25th Jan. No weed at present
2	Lasso (S)	0	0	0	0	25th Jan. No weed at present
3	Lorox	0	0	0	0	25th Jan. No weed at present
4	Swepp (S)	25.1	4.6	4.0	0	25th Jan. 1 narrow leaf beginning show
5	Swepp (G)	14.4	13.4	7.5	5.5	25th Jan. 1 narrow leaf beginning show
6	Mo 338	9.3	26.5	1.3	2.5	25th Jan. No weed at present.
7	Treflan	5.8	42.4	0.7	15.1	25th Jan. No weed at present.
8	Planavin	4.1	9.9	2.7	5.0	25th Jan. No weed at present.
9	Atrazine	3.1	0	0.7	0	25th Jan. No weed at present.
10	Telvar	3.5	0	0.7	0	25th Jan. No weed at present.
11	Cottoran	1.1	0	0	0	25th Jan. No weed at present.
12	Herban	10.3	6.7	1.3	0.7	25th Jan. 1 narrow leaf beginning show
13	2.4-D	9.2	11.5	5.9	7.5	25th Jan. No weed at present
14	Hand weeding	-	-	-	-	-
15	No weeding weeding	100.0 (577.33gr)	100.0 (124.33gr)	100.0 (49800gr)	100.0 (146.00)	Jan. 15, narrow leaves beginning to grow; Jan. 25, 2-3 narrow leaves showing, also 1-2 broad leaves

Table 3 - Investigation of Growth + Yield

No.	Kinds of herbicide	Height of Plant	No. of node (1 Plant)	No. of branch (1 Plant)	No. of pod (1 Plant)	Dry straw weight (rai)	Dry seed weight (rai)	Yield ratio of Standard
		cm				kg	kg	%
1	Lasso (S)	37.7	10.6	2.8	43.4	118.7	340.5 a	120.7
2	Lasso (G)	38.4	10.7	2.6	40.2	106.7	256.7ab	91.0
3	Lorox	26.0	10.0	2.4	37.1	57.3	149.0 b	52.8
4	Swepp (S)	31.4	9.1	2.3	32.7	88.0	284.8ab	102.0
5	Swepp (G)	32.4	9.8	2.8	35.4	89.3	289.9ab	102.8
6	Mo 338	40.3	10.8	2.8	42.2	126.7	267.3ab	94.8
7	Treflan	36.9	10.2	3.1	36.0	89.3	272.7ab	96.7
8	Planavin	30.0	9.6	2.4	29.3	72.0	202.3 b	71.7
9	Atrazine	20.0	9.4	3.3	68.1	10.7	16.2 c	5.7
10	Telvar	30.0	10.3	2.9	43.8	50.7	163.6 b	58.0
11	Cottoran	28.3	10.3	2.0	39.6	65.3	171.6 b	60.9
12	Herban	36.1	10.7	3.1	49.0	104.0	298.1ab	105.7
13	24 - D	21.3	8.9	2.2	34.9	58.6	129.0 b	45.7
14	Hand weeding	35.0	10.5	2.1	40.2	97.3	282.0ab	100.0
15	No weeding	35.2	9.3	1.7	24.2	65.3	149.1 b	5.29
		C. V. (%)					28.962**	

Note) Blooming period 18th Feb. maturity period 20th April.

Table 4 - Rate of Germination, Rate of Death after Germination

No.	Kinds of herbicide	Per rai	Germination %	% of damage after germination (% to No. of germination)	Remarks
1	Lasso (Solution)	Product 400 cc	96.7	0	
2	Lasso (Solution)	Product 300 cc	90.0	0	
3	Lasoo (Solution)	Compo-nent 300 g		82.1	If there is too much moisture in the soil, the beans will wither and die after germination
4	Lorox	100 g	96.7	10.2	If there is too much moisture in the soil, the beans will wither and die after germination
5	Sweep (Solution)	Produce 600 g	100.0	0	
6	Sweep (Solution)	400 g	93.3	0	
7	Sweep (Granule	Product 3 kg	86.7	0	
8	Swepp	Product 1 kg	86.7 86.7	0	
9	Mo 338 (Solution)	Compo-nent 200 cc	83.3	0	
10	Mo 338 (Solution	Compo-nent 200 cc	86.7	0	
11	Treflan (Emulsion)	Compo-nent 150 cc	70.0	0	
12	Treflan (Emulsion)	Compo-nent 100 cc	93.3	0	

No.	Kinds of herbicide	Per rai	Germination %	% of damage after germination (% to No. of germination)	Remarks
13	Planavin (Solution)	Component 150 g	86.7	0	
14	Planavin (Solution	Component 50 g	77.7	0	
15	Telvar (Solution)	Product	100.0	33.0	If there is too much moisture, the beans will wither and die because of the herbicide. Started to wither on Jan. 28.
16	Telvar (Solution)	Product 100 g	90.0	37.0	If there is too much moisture, the beans will wither and die becuase of the herbicide. Started to wither on Jan. 28.
			Germination period 19th Jan.	Investigation on 18th Feb.	

Table 5 Study of Weed ($1m^2$ investigated on 19th Feb.)

No.	Kind of Herbicide	Number of weeds Weed number		Weight of weeds (Dry weight) (gr)	
		Narrow	Broad	Narrow	Broad
1	Lasso (S)	0	0	0	0
2	Lasso (S)	0	0	0	0
3	Lorox	0	0	0	0
4	Lorox	0	0	0	0
5	Swepp (S)	10	0	2.5	0
6	Swepp (S)	37	0	4.7	0
7	Swepp (G)	12	0	nil	0
8	Swepp (G)	167	25	32.1	6.1
9	Mo 338	5	0	nil	0
10	Mo 338	0	0	0	0
11	Treflan	0	0	0	0
12	Treflan	5	8	nil	2.2
13	Planavin	0	0	0	0
14	Planavin	7	0	nil	0
15	Telvar	0	0	0	0
16	Telvar	11	0	nil	0

soil in the dry season contained 0.50% of organic matter. For this reason, we think that soybeans grown in the rainy season are very vulnerable to the effects of the herbicides. Also, as already mentioned, rainfall is constant and the herbicides 'move' quite easily, creating more dangers to the crop. One can say that the herbicides used in the rainy season will have a low efficiency in curbing the growth of weeds. What follows are the results of the experiments on each type of herbicides tested:

1) Lasso (Solution)

This type is very effective as in the case of usage in the dry season. That is, there are no adverse affects on rate of germination, growth and yield of the soybeans. Weeds will start to grow about 2 weeks after planting, the narrow type growing faster than the broad. (Faster than in the dry season by about 1 week, thus making the unit price of the chemical high.) It is important to find a type of herbecide that is as effective in curbing weeds as lasso but is cheaper.

2) Lasso (Granule)

Same as Solution.

3) Larox (Solution)

Because of the poisonous effects of the chemical on the crop, the amount used was reduced to half of that used for the experiments on the dry season crop. There was no withering after germination, but the amount of weeds increased. This chemical should not be used any more.

4) Swepp (Solution)

5) Swepp (Granule)

Because of the damage to the crop in the dry season experiments, the amount used was reduced. However, weeds grew easier than before; therefore, this chemical should no longer be used.

6) Mo. 338 (Solution)

This type presents no dangers to the crop, as in the case of cultivation in the dry season. It can be said that it has a high stability. Because of the rainfall and the high temperature, it is necessary to use more chemical, about 300 - 500 cc/rai. (product)

7) Treflan (Emulsion)

This type presents no dangers to the crop, as in the case of cultivation in the dry season. However, it cannot curb the broad type very effectively. It is necessary to experiment with a larger dosage than that used in the dry-season experiments. (about 200 - 300 cc/rai. (product))

8) Planavin (Solution)

Presents no dangers to the crop but cannot curb the narrow type very effectively. In the dry season experiments, some hills withered and died after germination. Therefore it is necessary to experiment further concerning the dangers from the chemical, and to use more chemicals than the amount used in the dry-season experiments.

9) Gesagard (Solution)

10) Cottoran (Solution)

These two types will kill the plants after germination and should not be used. There is, however, a form of Gesagard that will not harm the crop, but this depends on the location. Further experiments have to be conducted.

11) Herban (Solution)

Presents no dangers to the crop, but cannot control the broad type very well. Weeds begin to grow at the same time as with Mo. 338, and the amount used was more than that used in the dry-season experiments.

12) Igran (Solution)

This will kill the plants after germination and cannot be used.

The foregoing is a summary on the experiments on the use of herbicides both in the rainy and dry seasons.

To sum up, a larger quantity is needed in the rainy season, and the dangers that appeared during the dry season did not affect the rainy-season crop. (This depends on the type of herbicide used.) Generally, it is easier to use herbicides in the rainy season.

The logical step now is to find a type of herbicide that can effectively control the growth of weeds, will not damage the crop, and can be used in both the dry and rainy seasons. It is a fact that the extent of damage to the crop (caused by the herbicide) depends on the condition of the soil. Therefore experiments on this correlation should be made. The sandy loam type of soil at the Mae Jo Agriculture Experiment Station is a type in which crop damage from herbicide can easily occur.

Table 6 - Rate of Germination, Rate of Death after Germination

No.	Kinds of Herbicide	Germination (Investigation 29 July) %	Damage after Germination
1	Lasso (S)	54.0	0
2	Lasso (G)	41.3	0
3	Lorox (S)	51.4	0
4	Swepp (S)	50.5	0
5	Swepp (G)	43.9	0
6	Mo. 338 (S)	39.9	0
7	Treflan (E)	41.5	0
8	Planavin (S)	25.3	0
9	Gesagard (S)	33.3	100
10	Cottoran (S)	33.3	100
11	Herban (S)	51.5	0
12	Igran (S)	29.0	100
13	Hand weeding	26.4	
14	No weeding	30.3	

Note: S in ( ) is Solution
G in ( ) is Granule
E in ( ) is Emulsion
Blooming period 27th Aug.
Maturity period 13th Oct.

Table 7 - Study of Weed (Weight of body $1m^2$ investigated on 1st Sep.)

No.	Kinds of Herbicide	Narrow	Broad	Total	Time of Growth of Weeds
1	Lasso (S)	33.5%	26.3%	34.7%	Broad and Narrow started to grow on August 9. Narrow will grow faster by 1 - 2 leaves.
2	Lasso (G)	45.7	15.8	43.8	Weeds will begin to grow at same time as Mo. 338.
3	Lorox (S)	62.8	92.1	64.7	Broad begin to grow on 9 Aug. Narrow grow slower than Mo. 338.
4	Swepp (S)	61.6	50.0	60.8	Narrow grow faster than Mo. 338. Broad grow slower than Mo. 338.
5	Swepp (G)	63.9	68.4	64.2	On 9 Aug. little Broad; More narrow.
6	Mo. 338(S)	53.6	107.9	57.1	Around 9 Aug. there are 1 - 2 narrow leaves, 1 leaf of broad
7	Treflan (E)	30.4	52.6	31.9	On 9 Aug. Weeds grow at the same time as Mo. 338.
8	Planavin(S)	43.9	13.2	42.1	On 9 Aug. A lot of narrow present. Broad grow at the same time as Mo. 338
9	Gesagard (S)	0	0	0	On 9 Aug. No weeds present.
10	Cottoran(S)	0	0	0	On 9 Aug. No weeds present.
11	Herban (S)	68.3	28.9	65.9	Weeds will grow at the same time as Mo. 338.
12	Igran (S)	0	0	0	On 9 Aug. No weeds present.
13	Hand weeding	0	0	0	
14	No weeding	100.0 (5.49kg)	100.0 (0.38kg)	100.0 (5.87kg)	

Note: S in ( ) is solution.
G in ( ) is Granule.
E in ( ) is Emulsion.

IV. Experiments on Soybean Cultivation in the Dry Season of 1972

The experiments are not complete at this time, and so the results are not available. The experiments are as follows;-

1) The types of herbicide used, locations of experiments

Experiment A

No.	Kinds of Herbicide	Component	Amount Per Rai
1	Lasso (Solution)	43.7%	500 cc
2	Lorox (Solution)	50.0	200 g
3	Mo. 338 (Solution)	20.0	400 cc
4	Treflan (Emulsion)	44.5	200 cc
5	Planavin (Solution)	75.0	150 g
6	Herban (Solution)	-	250 g
7	Amiben (Solution)	-	500 cc
8	Gesagard (Solution)	-	100 g
9	Hand weeding		
10	No weeding		

Experiment B

No.	Kinds of Herbicide	Amount Per Rai
1	Amiben	1780 cc
2	Amiben	1000
3	Amison	726 g
4	Amison	363
5	Amison	181
6	Amchem 70 - 25	1816 cc
7	Amchem 70 - 25	908
8	Amchem 70 - 25	454
9	Preforan	1816 cc
10	Preforan	908

No.	Kinds of Herbicide	Amount Per Rai
11	Perforan	454 cc
12	B - 3015	600 cc
13	B - 3015	300
14	Saturn	500 cc
15	Saturn	250
16	G.S. 16080	600 gr
17	G.S. 16080	300
18	G.S. 16080	150
19	Maloram	600 gr
20	Maloram	300
21	Maloram	150

2) Time of planting - January 6th

3) Date of spraying chemicals - January 7th

4) Area per 1 section, both experiment A+A-15 m^2 per 1 section

5) Amount of fertilizers used, N - 3, P - 12, K - 12 kg/rai (Applies to both experiments)

Apart from what has been mentioned above, the experiments are being carried out based on the experiments carried out during the dry season of 1971.

TEST ON THE DOSAGE AND TIME OF FERTILIZER APPLICATION

I. Purpose

There are many means to increase the yield of soybeans, and the application of fertilizers is one of such means.

Though the recent survey on the actual state disclosed that soybeans in some areas enjoy high soil productivity and exhibit very smooth growth conditions, in most parts covered by the survey, the growth is poor in both wet and dry season cropping.

As regards the wet season cropping, it was frequently noticed that the abundant rainfall and high temperature caused eluviation of nutrient and organic matter contents in soil, making the soil fertility very poor for the growth of soybeans.

In the case of the dry season cropping, soil fertility is fairly good as it is carried out as the secondary cropping in the paddy field, but there exist other factors such as the wild growth of weeds which was noted to absorb the greater part of fertilizers, causing poor growth of soybean stems and leaves.

In addition to these facts, it is unknown what response local varieties would show to fertilizers and how the yield would be influenced by fertilizer application due to the complete absence of data.

It is generally accepted that local varieties which have not been subjected to improvement effort or varieties similar to them produce a poor yield increase by fertilization, which is very often too low to pay for the capital input in fertilizers.

Application of base fertilizers before planting is considered to produce the maximum effect, but it is not certain that this principle holds true in Thailand where soybeans are cultivated under unique climatic conditions.

For this reason, the test was conducted to find out the suitable fertilization method, i. e., to choose between the base fertilizer application and additional fertilizer application, using a Thai variety and a Japanese variety which is considered to show outstanding response to fertilizers.

The test was carried out with the assistance offered by Mr. Amnuay Tongdee of the Department of Agriculture, the Thai counterpart worker specializing in cultivation, and by Mr. Charoon Aree and other staff of Mae Jo Agricultural Stations who worked under his guidance. Deepest gratitude is here by expressed for their valuable cooperation.

II. Test Method

Test A: 1971 Dry Season Crop

1. Test Lot

No.	Dosage (kg/rai)	Time of Application
1	40 (N-3, P-12, K-12)	Before seedling
2	80 (N-6, P-24, K-24)	Ditto
3	40 (N-3, P-12, K-12)	14 days after seedling
4	0	-

2. Test Variety

SJ-2 (Thai variety) and Bonminori (Japanese variety)

3. Planting Time

January 15

4. Planting Method

Distance between rows - 50cm, distance between hills - 20cm, number of plants per hill - 2.

5. Area per Lot and Block Design

1 lot covering an area of $10m^2$ (2m x 5m), 3 replications. Randomized complete block design.

6. Test Place

Mae Jo Agricultural Experiment Station; secondary cropping in paddy field, pH - 6.1, organic matters - 0.77%, phospho - 29.1 ppm, potassium - 70ppm.

Test B: 1971 Wet Season Crop

1. Test Plot

No.	Dosage (kg/rai)	Time of Application
1	0	-
2	40 (N-3, P-13, K-12)	Before seedling
3	80 (N-6, P-24, K-24)	Ditto
4	40 (N-3, P-12, K-12)	15 days after seedling
5	80 (N-6, P-24, K-24)	Ditto

2. Test Variety

SJ-2

3. Planting Time

June 18

4. Planting Method

Distance between rows - 50cm, distance between hills - 20cm, number of plants per hill - 2.

5. Area per Lot and Block Design

1 lot covering an area of $15m^2$ (3m x 5m), 3 replications. Randomized complete block design.

6. Test Place

Mae Jo Agricultural Experiment Station; upland field, pH - 6.3, organic matters - 0.59%, phospho - 32.2ppm, potassium - 159ppm.

In addition to the test described above, SJ-1 was planted on February 23 for 1971 dry season cropping and SJ-2 and Bonnominori on June 2 for wet season cropping to study the fertilization condition and the rate of germination.

III. Test Results

Test A: 1971 Dry Season Crop

As is clear in Table 1, all the test varieties showed a low germination rate by base fertilizer application. This is considered due to the detrimental effect of fertilizers suffered by the seeds although 3cm thick soil was inserted in between the fertilizers and seeds to prevent their direct contact. Since the germination ability of local varieties is already low, it is problematic if it would be further degraded by the effect of fertilizers.

The growth and yield are as shown in Tables 2 and 3.

The stem height of both SJ-2 and Bonminori produced no significant differences between treated lots, though Bonminori's growth and yield was somewhat higher in fertilized lots than in the non-fertilized lot.

The number of nodes and the number of branches both produced no significany differences, but SJ-2 presented a larger value in the fertilized than in the non-fertilized plot. The stem height of Bonminori was made very short due to short day-length and high temperature, but that of SJ-2 produced difference by fertilization effect as it ranged from 40 to 50cm.

The straw weight, on the other hand, showed a larger value in lots where base fertilizers were applied, and this trend was noticed also with the number of pods and 100 grain weight, and consequently also with

the seed weight. However, the difference caused by fertilization was small, and no significant differences were seen between lots after statistical analysis.

Introduced varieties like Bonminori grow to a height of 60 to 70cm. in Japan, but in Thailand, their growing period is reduced remarkably by the extremely short daylength and high temperature. The resultant repressive effect on the growth is considered to have made it difficult to discover the effect of fertilization treatment. SJ-2, on the other hand, produced detectable significant differences because of its low response to fertilization.

Test B: 1971 Wet Season Crop

The results of germination rate observation conducted in much the same manner as applied for the dry season crop are shown in Table 1. The table indicates that the germination rate declined by fertilization although 3cm thick soil was similarly interlaid between the seeds and the fertilizers.

The growth and yield are shown in Table 4.

The stem height produced no significant defferences between treated lots, but tended to show a highervaluein fertilized lots as in the case of the dry season crop. Differences between fertilized lots were not made clear.

No differences were discovered either in the number of nodes and the number of branches. As for the number of pods, the differences were not clear except that Lot No. 3 (80kg of base fertilizers) appeared to have produced a larger number. The 100 grain weight seemed to be large in Lot No. 3 and Lot No. 4 (40kg of additional fertilizers).

By reason of these facts, the largest straw weight was observed in Lot No. 3, followed by Lot No. 4, and a very small value was observed in the non-fertilized lot. The same trend was noticed in the score of leaf area which was largest in Lot No. 3 with a value of 2.5 and the value in

the non-fertilized lot was as small as 1.7. Accordingly, the highest yield was attained in Lot No. 3 (80kg of base fertilizers) where a large value was observed in the leaf area, number of pods and 100 grain weight. The yield in Lot No. 3 was larger by 25.7% compared with the non-fertilized lot. The smallest yield was observed in Lot No. 5 (80kg of additional fertilizers).

The yield described above suggests that in the wet season cropping, application of 40kg of base fertilizers produces no effect due to eluviation, and fertilization effect manifests itself by 80kg application. It also suggests that if 40kg of fertilizers are to be applied, this is less subjected to eluviation after manuring and therefore more effective as evidenced by the 16.3% excess over the non-fertilized lot. In case of 80kg of additional fertilization, the low yield rate is considered to have resulted from the fertilizer damage which caused a small number of branches and lighter 100 grain weight and straw weight.

It is to be noted, however, that the 1971 wet season crop was seriously affected by the outbreak of rust which not only cut down the yield but also caused disturbance to the differences between lots. A similar study should therefore be conducted next year for re-stydy.

Soybeans started lodging about 10 days before the flowering time, and this coincided with the development of rust. The score of leaf area investigated at this time is shown in Table 4 which indicates that the disease caused the fall of a substantial volume of leaf within a very short time.

Results of Tests A and B introduced above bring to light the fact that base fertilizers produce damage on soybeans and impair the germination ability. This is quite problematic since it adds to the difficulty already involved in maintaining the germination ability. To bring about a solution for this problem, it would be safer to resort to additional fertilizer application.

As regards the growth after germination, the test results disclose the following facts.

In case of the dry season cropping, eluviation of fertilizers is smaller than in the wet season cropping and, therefore, application of base fertilizers is recommendable; but in the case of wet season cropping, the fertilizer eluviation caused by rainfall makes the standard dosage of base fertilizers deficient and calls for a dosage twice the standard value to attain the fertilization effect.

If the standard dosage is to be observed, additional fertilization would prove more efficient than base fertilization. However, it is to be noted that a heavy dosage of additional fertilization cause damage to soybeans.

From the findings described above, it is considered that smooth germination and highfertilization effect by a small dosage can be expected by sowing many seeds for base fertilization in consideration of possible impediment to germination, and by applying within 10 days germination for additional fertilization.

At the present stage, however, it should be remembered if fertilizers are to be applied to SJ and other strains and varieties of Thailand, which do not show very sharp response, that determination to invest in fertilizers should be made in due consideration of not only the balance between the necessary capital input and expected yield but also the land fertility and other factors.

Table 1 Fertilization Dosage and Germination Rate

No.	Variety	Planting Time	Date of Germination Survey	Date of Germination Rate %	Dosage (kg/rai)	Germination Rate %	Rate to Non-fertilization %
1	SJ 2	15 Jan.	15 Jan.		3 12 12	50.0	66.7
					6 24 24	55.0	73.3
					0 0 0	75.0	100
2	Bonminori	15 Jan.	15 Jan.		3 12 12	40.0	80.0
					6 24 24	30.0	60.0
					0 0 0	50.0	100
3	SJ 1	23 Feb.	1 Mar.	90.0	3 12 12	68.1	88.8
					0 0 0	76.7	100
4	SJ 2	2 Jun.	9 Jun.	73.0	3 12 12	49.4	85.0
					0 0 0	58.1	100
5	Bonminori	3 Jun.	9 Jun.	89.0	3 12 12	61.3	87.0
					0 0 0	34.1	100
6	SJ 2	18 Jun.	28 Jun.	75.0	3 12 12	61.3	87.0
					6 24 24	62.2	88.4
					0 0 0	70.4	100

Table 2 Growth and Yield (SJ-2)

Treatment	Flowring Time	Maturing Time	Height of Plant cm.	Number of Branch	Number of Nodes on the Main Stem	Number of Pods	100 grain Weight gr.	Straw Weight kg/rai	Seed Weight kg/rai
1	2 Mar.	24 Apr.	47.7	7.9	12.5	99.9	14.2	497.0	249.7
2	2 Mar.	24 Apr.	48.5	7.1	12.2	116.7	14.3	509.2	248.1
3	2 Mar.	24 Apr.	44.7	6.6	12.5	105.2	14.3	435.0	211.4
4	2 Mar.	24 Apr.	53.4	4.3	10.8	69.3	14.0	450.1	233.2
C.V.%			N.S. 5.981	N.S. 19.933	N.S. 6.429	N.S. 27.166	N.S. 1.242	N.S. 17.47	N.S. 12.74

Table 3 Growth and Yield (Bonminori)

Treatment	Flowering Time	Maturing Time	Heighg of Plant cm.	Number of Branch	Number of Nodes on the Main Stem	Number of Pods	100 grain Weight gr.	Straw Weight kg/rai	Seed Weight kg/rai
1	24 Feb.	8 Apr.	15.6	4.6	5.4	40.7	15.5	35.2	195.2
2	24 Feb.	8 Apr.	14.7	4.3	5.6	38.1	25.4	35.2	189.9
3	24 Feb.	8 Apr.	15.7	5.9	5.8	38.3	15.0	30.0	187.7
4	24 Feb.	8 Apr.	13.1	4.7	5.1	31.7	14.4	24.4	160.1
C.V.%			N.S. 9.249	N.S. 17.099	N.S. 16.292	N.S. 13.501	N.S. 2.698	N.S. 11.34	N.S. 11.55

Table 4 Growth and Yield

Treatment	Flowering Time	Maturing Time	Height of Plant cm.	Number of Branch	Number of Nodes on the Main Stem	Number of Pods	100 grain Weight gr.	Straw Weight kg/rai	Seed Weight kg/rai	Score of Leaf Area	
										Flowering Time	After Lodging
1	3 Aug.	27 Sep.	72.9	10.0	13.4	88.3	7.1	181.0c	106.3bc	1.7	0.9
2	3 Aug.	27 Sep.	72.9	9.8	12.7	81.2	7.6	187.0c	107.0bc	2.0	1.4
3	3 Aug.	27 Sep.	77.5	9.0	14.2	91.2	8.5	229.7a	133.7a	2.5	1.4
4	3 Aug.	27 Sep.	80.6	8.9	13.7	76.8	8.5	213.7b	123.7ab	1.8	0.8
5	3 Aug.	27 Sep.	77.6	8.8	13.9	84.9	6.5	193.5c	97.4c	2.1	0.9
C.V. %			N.S. 8.50	N.S. 9.94	N.S. 8.63	N.S. 11.37	N.S. 15.45	** 8.12	* 12.79		

STUDY ON THE RELATION BETWEEN GROWTH OF SOYBEANS AND MOISTURE CONTENT OF SOIL

1. Purpose

While the dry season soybeans are grown as the secondary cropping in irrigable paddy fields, the past survey conducted on the actual state of soybean cultivation by farmers disclosed the great importance to be attached to the relation between the growth of soybeans and the moisture content of the soil.

Although most farmers supply irrigation water only two or three times a month during the dry season cropping period, there is no rainfall at all in this period and the consequent rise of temperature and drying of soil cause some fields to crack in places. The result is that the soybean roots are cut and both the stem and leaves are allowed to grow to a small size. When water is drawn for irrigation two or three times a month, the entire field is submerged and the logged water is not drained but left as it is until it naturally goes down.

The wet injury caused by this irrigation practice impairs the vital function of the root and brings about its death in the worst case as reported by some farmers in Sampatong Province.

The vegetative growth of soybeans is largely impeded by such repetition of dry condition and over-wet condition, developing the fall of flowers, buds and pods after the flowering time and causing poor fruiting of seeds. Soybean grains are therefore small in size.

Under the existing situation, it is impossible to promise any large yield for farmers.

Influence of soil moisture on soybeans has been tested in many countries of the world, including Japan, where studies probing deeply into this subject have been reported on many occasions. From the findings contained in these reports, it can be said that the soybean cultivation in Thailand is conducted in an extremely rough and haphazard manner.

In an effort to find out the optimum moisture content in soil which ensures smooth growth and high yield of soybeans in Thailand, an experimental sloping field specified below was formed and the growth and yield at different moisture contents have been studied so far.

As this test serves to make it easy for any layman, not to mention agricultural engineers engaged in it, to see what moisture content is most suited for the growth and high yield rate of soybeans, it is instrumental in enlightening the people on the importance of soil moisture in the dry season soybean cropping. It is for this reason that the method of sloping field was adopted in commencing the test on soil moisture.

It leaves no doubt that the yield of soybeans in Thailand will be doubled if an irrigation method suitable for the dry season cropping is devised and put in practice.

II. Test Method

1. Size of Sloping Field

   10m x 10m

2. Water Management

   Water is to be supplied constantly to maintain the retention pond water level at a fixed value.

3. Test Place

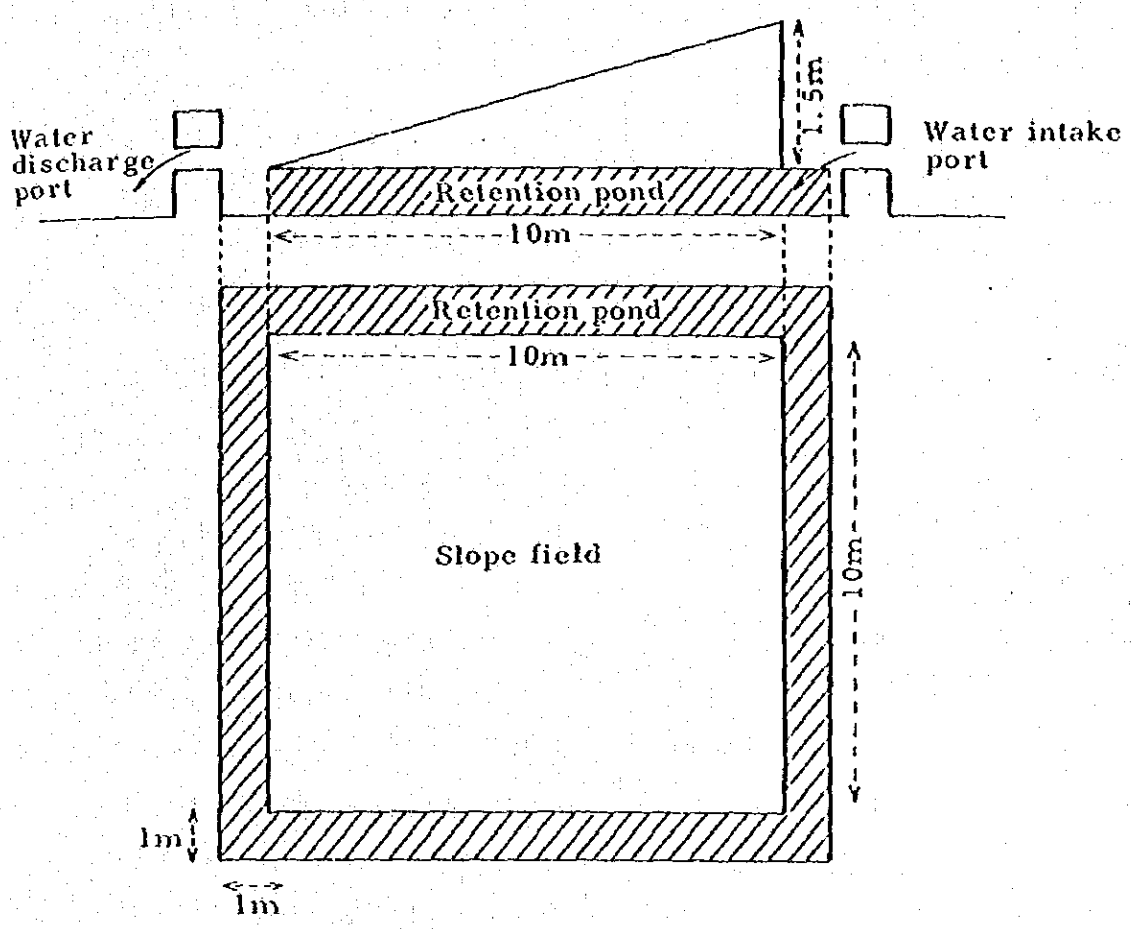
   Mae Jo Agricultural Experiment Station

4. Planting Time

   January 20, 1972

5. Test Variety

   SJ-1 and SJ-2 for detection of difference in the response to the soil moisture.



6. Planting Density

Distance between rows - 50cm, distance between hills - 10cm, number of plants per hill - 2.

7. Dosage of Fertilizer Application (kg/rai)

N-3, P-12 and K-12

8. Soil moisture to be recorded every 10 days by using a tensiometer.

INTRODUCTION - MAIN AIMS AND PROBLEMS

The cultivated area of rainy season soybean of which main parts are located in Sukothai Province, accounts for about 90% of the total soybean area in Thailand, whereas dry season soybean accounts for about 10% with Chiengmai Province being its main producing area.

It is estimated that more than 60 per cent of soybeans planted in Sukothai is SJ-1, and a few nameless varieties with black seed coat rank second but recently there has been a rapid change to SJ-1. A native variety, Pakchong, is grown in the areas of Saraburi Province and its neighborhood during the late rainy season. On the other hand, in the northern region, SJ-2 variety is mostly used for dry season planting (more than 80% of total cultivated area) together with some native varieties such as SB 60 and Sansai, but there has also been a rapid change towards SJ-2. There are two or three other native varieties grown in small areas of the northern parts. The selection and survey of these native varieties were not especially carried out, but in general they are similar to SB 60, Sansai and Pakchong.

History and origin of Thai soybean varieties were discussed in details in the "Report by the Experts on Soybean Development Cooperation Dispatched to Thailand" (1969). It was explained in the report that SB 60 and Pakchong varieties were selected from the collection of native kinds while the recommended SJ-1, SJ-2 and SJ-3 varieties were selected from the introduced-materials from Japan and Taiwan.

The native varieties, SB 60, Sansai and Pitsanulok, are late maturing with long stems and white pubescence. They are very much similar to one another and all are suited for dry season planting. Their seeds are extremely small with light brown hilum. The Packchong has shorter branches than the SB60 and Sansai, and is suitable to be planted toward the end of the rainy season. Its seeds, however, are larger with somber seed coat and brown hilum.

The recommended variety SJ-1 apparently has an indeterminate type of growth with middle maturity and tall plant height. It issuited for planting in the rainy season. The seeds are somewhat smaller than that of Pakchong showing black hilum. Among the introduced-varieties, Pai Meiton Bean, Dalat B, and Coker 102 are very similar to SJ-1. The SJ-2 and SJ-3 are also quite similar, and both are later maturing than SJ-1, and hence are usually suitable for the dry season. They are characterized by non-shattering with no losses of yield during harvesting, and the seeds are as big as the SJ-1 seeds, showing dark brown hilum. Recently there has been an increase in the planting more of SJ-1 and SJ-2 varieties in accordance with the multiplication system of soybean plantation by the Department of Agriculture and the Department of Extension.

The following data show the main characteristic of SJ-1, SJ-2, SB-60 and Pakchong varieties.

	Growing period days**	Plant height cm*	Number of* nodes on the main stem	Lodging* score	100** grain weight g	Seed** yield kg/rai	Remarks
SJ-1	96.0	69.2	15.4	1.4	12.8	316.6	Indeterminate type
SJ-2	104.3	59.5	14.8	2.0	12.4	359.1	Resistant to shattering
SB 60	108.0	83.8	18.0	2.7	9.3	235.9	Resistant to shattering
Pakchong	101.6	45.2	13.1	1.6	14.5	256.0	

* Averages of following four experiments

** Averages of three, excluding Exp. -2 which had serious damages by soybean rust.

1. Preliminary yield trial at Mae Jo Agri. Exp. Sta. Dry season of 1971.
2. Yield trial at Mae Jo Agri. Exp. Sta. Rainy season of 1971.
3. Yield trial in the late planting time during the rainy season at Mae Jo Agri. Exp. Sta. Rainy season of 1971.
4. Yield trial at Sisamrong Agri. Exp. Sta. Rainy season of 1971.

The recommened SJ-1 and SJ-2 varieties have some weak points in yield, lodging (in the rainy season), their resistance to rust - disease and seed quality. However, their yields are higher than those of the native varieties, and so they are considered to be acceptable in the first step of the soybean production plan.

The following is a discussion on the main aims and problems in the breeding work:-

1. Maturity of Varieties (Growth Period)

Maturity of soybean has a high correlation with seed yield, and in general the later varieties show a higher yield if there are no damages accompanied with maturity. The growth period of SJ-2 variety used for dry season planting and SJ-1 variety used for planting in the rainy season is about 100-105 days.

The growing period of dry season soybeans is limited by the planting time which must be after the rice is harvested and the harvesting time before the rice season starts. Soybean harvesting must be carried out in May before the rainy season comes so as to obtain high quality seeds. The planting time, on the other hand, varies depending on locations and on the farm families themselves depending on how much time they need in harvesting and shelling rice grain, maintenance of irrigation ditches and dikes before the preparation for soybean planting. For instance, the possible cultivated period of soybean in Chiengmai is from early December to the end of April. The minimum temperature of 10°C - 12°C in Chiengmai often occurs between the end of December and early January, and if the flowering time of soybean comes during this period, the low temperature will cause damage to podding so that the planting time must be later than the middle of December. However, this late planting time still provides chances for soybean varieties with a growth period up to 120 days to be planted. Then later varieties than SJ-2 may be desirable for high yielding of dry season soybean.

It is a difficult task to determine a suitable soybean growth period for rainy season planting. The planting time varies depending on the amount of rainfall in each location. The possible growth period is about 150 days starting from early and the middle of May till the middle and the end of October.

In Sukothai Province, soybean planting is done before cotton plantation, and the growth period is thus very limited. Careful consideration must be given to the yield and economics of soybean together with cotton. The favorable maturing periods of soybean is still very complicated since there is not yet complete data on this matter. Thus it is accepted at present that the maturing period of SJ-1 be used as a breeding standard. However, there may be some changes in accepting this if there is an increase in planting only soybeans without rotation with cotton in the area and in other regions such as the North East.

In the case of planting only soybeans in the rainy season, it is also difficult to breed a late variety to be planted between early and mid-May and harvested between the middle and the end of October, because 150 days of growth period is considered too long and the plants may develop too thick causing poor pod-setting. Furthermore, the number of lodged plants may increase due to the rain resulting in a decrease of yield. It is sometimes found that farmers plant soybeans from the end of June to the middle of July and harvest them at the end of October so that they can avoid heavy rainfall during harvesting time. In this case, later varieties than SJ-2 may be more suitable due to the day-length and other climatical conditions.

2. Germinating Ability of Varieties

The field experiments showed that there was a difference in germinating ability among varieties even their seeds were kept in good conditions with low temperature and humidity. Thai native

varieties, SB 60 and Pakchong, and the recommended varieties, SJ-1 and SJ-2, have a good germination percentage, while some of the introduced varieties have low germination. Even in those varieties the low germination percentage often occurs if it rains heavily after planting resulting in very compact soil surface. The development of high germinating varieties with good storage of seeds will help in increasing the yield.

3. Adaptibility of Varieties to Planting Season and Region

At the present time, there are three types of soybean plantings such as early rainy, late rainy and dry seasons.

The above-mentioned three planting periods of soybeans will certainly not be carried out continuously in one area. The first planting in the rainy season occurs mostly in the upland of the Central Plains, and there is a plan to extend it to the North Eastern region. The dry season planting is done in Chiengmai after the rice season, and it is planned to be grown in paddy fields of Chainat Province and also in the Noth Eastern Region.

The varieties of soybeans planted in different areas vary mainly due to soil conditons, especially the fertility rate. The variations in planting time are mainly due to other factors such as day length, temperature and rainfall (proportion of water content in the soil).

How far a soybean variety can adapt itself to the above-mentioned environmental factors is still a major problem to be solved. It would be ideal if it is possible to grow one variety in any place and season. However, it is unlikely that, such an ideal variety can be breeded within a short period of time. The variety suitable for the rainy season planting must have strong stems with high resistance to rust disease while the one grown in the dry season must have big basic growth and resistant to shattering because of the short day length and high temperature with low humidity during harvesting time.

The same materials were tested in the breeding experiment at Mae Jo Agriculture Experiment Station both for rainy season and dry season plantings, since irrigation facilities were available. The varieties suitable for rainy season planting were selected separately from those suitable for dry season planting. The experimental results during the two years showed that varieties used for dry season planting could be used for late rainy season planting.

Since the volume of fertilizer applied and the density of plantation differe among varieties due to their locations and planting season, there is a range of possibility to increase the scope of adaptation. For instance, varieties suitable for dry season planting will grow too thick if planted in the rainy season causing lodging and poor podding, but if they are planted with low fertilizing level or in unfertile soil, even in the rainy season they may to some extent adapt themselves to these conditions. Further study is needed regarding this matter.

4. Adaptibility of Varieties to Present Cultivation Method and the Further Improved Hypothetic Cultivation Method

Generally, the growing of soybeans in Thailand is carried out without the use of fertilizer. The dry season planting is also done without tilling. Furthermore, the general cultivation methods, such as weeding, plant protection and irrigation, are far different from those performed in Japan and in U. S. A. However, the methods practiced here should not all be neglected since they have some relations to environmental factors in Thailand and its complicated economic structure.

Since furture improvement of a hypothetic cultivation method is still uncertain, there is still a problem in determining conditions of the breeding field. Our normal practice is plowing the breeding field both in the rainy season and the dry season with the application of fertilizers. (3kg/rai, 12kg/rai, 12kg/rai and 1.5-4.0kg/rai of

N, P_2O_5, K_2O and $MgSO_4$, respectively, were applied). As for the promising strains, a special experiment was carried out combining the levels of fertilizing and non-fertilizing with the different levels of density of plants. Plowing was also conducted even in the dry season planting in the breeding field, and it is expected that this will be accepted as a general cultivation practice in the future. We have also considered the selection of varieties suitable for non-fertilizing condition becuase general prices of fertilizers in Thailand are very high. However the previous study showed that rainy season planting can be carried out with minimum use of fertilizer.

5. Chemical Compositon of Seeds

Thailand needs soybeans with a high percentage of fat for the purpose of oil extraction. According to our survey, it was found that the recommended varieties SJ-1 and SJ-2 contained a high % of fat, when compared with the varieties of soybeans prevalent elsewhere. SJ-1 and SJ-2 are considered in the high fat content group. On this point it can be said that there is a definite future for the development of SJ-1 and SJ-2. In the first stage of selection, no detailed analysis of chemical contents was made. Chemical analysis was carried out for the materials tested in preliminary performance tests and performance tests.

From the historical point of view, Thai soybeans has long played an important role as protein food. In considering that a lack of nutrition foods still exists in the North Eastern and the North regions, the value of soybeans as a source of protein should therefore not be overlooked.

6. Varieties Suitable for Poor Fertile Soils in the North East

In the North Eastern region the soil is predominantly sandy, containing very low organic matters, thus having low productivity of crops. The pH is also low ranging, around 5.0 - 5.5. The

cultivation of the recommended varieties, SJ-1 and SJ-2, in this region will produce little setting of nodules. (In some cases, there are no nodules at all.) However, where there has been land improvement, or where the soil is fertile, there will be a high rate of nodules setting. Therefore, it can be said that soil improvement is very important for soybeans cultivation in the Northeast.

It is clear from our experiment that in this region, there are some races of nodule bacteria which are not compatible with SJ-1 and SJ-2 but are compatible with only some genotypes, such as SB 60. In the area where there is little land improvement, the growing of SJ-1 and SJ-2 varieties is not recommended. The native varieties such as SB 60 should serve the purpose at present. However, a suitable variety of soybeans with high yield and good quality for the region should be developed as soon as possible.

7. Resistance to Rust Disease

The damage suffered from rust disease in Thailand at present is confined to soybeans grown in rainy season in the north region. When soybeans are planted in the late rainy season, there is also negliable damage from rust disease even in the North. This is probably due to the amount of rainfall, humidity in the air and the temperature. From now on, due to the rapidly increasing area of soybean cultivation, the damage from rust disease will naturally increase. From the results of our experiments for the past 2 years, the greater the damage from rust diseases, the less the yield.

Fortunately, among our introduced varieties, there are some varieties with high resistance to the rust disease. It is therefore necessary to do further research on disease resistance of these varieties. At present, such experiments are being carried out, by cross breeding of these varieties with the Thai varieties.

8. Size of Seeds

Seed size of the Thai soybean varieties is very small; 100 seeds of SJ-1, SJ-2 and Pakchong weigh only 12-15g, whereas the same amount of SB 60 weighs 8-10g. Once the breeding seeds are introduced for growing in Thailand, the size of most of the varieties will decrease. The cause is not yet known in detail, but it is believed that the high temperature during the maturing period, particularly at night time, might be one of the causes. In view of this, the assumption that the big seed varieties are unsuitable for tropical area may be unture. But there is very low frequency of big seed plants in hybrid materials originated from crosses between the Thai variety with small seed and the Japanese variety with large seed.

If possible, we would like to increase the seed size of Thai varieties to the same level of commercial varieties in the world. Thailand, however, requires soybeans with a high fat content (oil extraction). Thus, the selecting process does not take much into account the size of seeds. In this connection, it is imperative that more time be spent on detailed research and study on this matter.

9. Accelerating of Generation

In Thailand, soybeans can be grown all year round with the help of irrigation facilities. The medium variety will take about 100 days to mature. If there is no selection, it is possible to engage in triple cropping.

Growing of parent for crossing, it's F_1 and F_2 generations in some crosses were carried out within 10 months. After the F_3 generation, due to insufficient labor and the increase in material, it is not possible to cultivate hastily. In general, cultivation is carried out both in the dry and rainy season. In case there are adequate facilities and labor, the process only to accelerate generation can be made as far as the F_5 or F_6 generation, after which the process of individual selection can be made.

In the future, if there is international cooperation, the breeding operation can be carried out efficiently and rapidly.

In completing breeding experiments in this report, the researchers were aided by the research officers who were in charge of soybeans in the Department of Agriculture, the chiefs of each agriculture experiment station, and the chiefs of each seed multiplication station. In particular, the Chief of the Mae Jo Agriculture Station, Mr. Sunan La-ongsri, rendered great assistance. We wish to express our deep appreciation to all concerned.