SUMMARY REPORT

BY

JAPANESE TECHNICAL ADVISORY TEAM

FOR

SOYBEAN PROJECT IN THAILAND

January 1972

OVERSEAS TECHNICAL COOPERATION AGENCY

INTRODUCTION

The Primary Products Development Project in Thailand, implemented at the request of Thai Government, was intended for adjusting the trade balance between Thailand and Japan and augmenting the purchase of primary products from Thailand. For these purposes, two survey teams were dispatched to Thailand, the first team sent in January 1968 and the second in March of the same year, and experts were also dispatched for a short stay in Thailand to make studies on the selection and introduction of suitable soybean varieties as well as on the improvement and guidance of soybean cultivation method. Based on the findings of these studies, three experts specialized in breeding, cultivation techniques and marketing respectively were sent to Thailand in April and May 1970 who have extended cooperation in the selection of improved varieties and establishment of breeding and cultivation techniques. Cooperation offered by these three experts were aimed at accelerating the production of soybeans meating the demand of Japanese market through the improvement of soybean productivity, reduction of production cost and improvement of quality.

Because a period of a year and a half has already elapsed since this project was initiated, the present itinerant quidance service was conducted primarily for clarifying the progress so far made, pointing up problems now confronting the project, and mapping out measures for solving such problems.

Improvement of marketing system was not included in the item of our team. However, this question is very likely to become an important subject when soybeans is considered as an export products in the future. It is essential, therefore, that a more detailed study and research is made in advance to provide a solution to the problem.

On behalf of the party members, I wish to express my sincere thanks for the valuable cooperation and assistance offered by Department of Agriculture of Thai Ministry of Agriculture and the many officials and staffs affiliated with the project.

Kaoru Ozaki
Leader,
Chief of Upland Crop Division,
Kyushu National Agricultural
Experiment Station

January 1972

Formation of Technical Advisory Team

Leader	Dr. Kaoru Ozaki	General control and cultivation techniques	Chief of Upland Crop Division, Kyushu National Agricultural Experiment Station, Ministry of Agriculture and Forestry
Member	Masataka Saito	Breeding	Chief of Soybean Breeding Div., Tokachi Prefectural Agricultural Experiment Station, Hokkaido
Member	Tsutomu Hasegawa	Plant protection	Chief of Entomological Div., Tohoku National Agricultural Experiment Station, Ministry of Agriculture and Forestry
Member	Shinya Masuda	Coordination	Primary Products Development Cooperation Office, Overseas Technical Cooperation Agency

I. DESCRIPTION AND EXISTING STATE OF COOPERATION PROJECT

1. Cropping Season by District

While the major soybean producing areas in Thailand are the central and northern districts, the Thai government is hoping to increase the soybean cropping area in the maize prodicing area of the central district and in the northeastern district. Though the present survey only covered the northern district, upper central plain and part of northeastern district, the team considers that the future cropping pattern and cropping season by district will be as follows.

(1) Northern district - dry season cropping (after paddy harvesting).

(2) Upper central plain - 1st rainy reason cropping (intercropping between cotton cropping seasons).

(3) Central high land - 2nd rainy season cropping (after maize harvesting).

(4) Northeastern district - dry season cropping (after paddy cropping).

(5) Northeastern district - rainy season cropping (to be introduced into the kenaf producing area).

Soybeans are cultivated in substiantlly large quantities in districts (1) and (2). Chiengmai province is the major producing area in district (1) and Sukhothai province in district (2).

In districts (3) to (5), however, farm households are considered to have a relatively or extremely short experience in soybean cropping.

Under the soybean production project of the Thai government, it is planned that the present annual production of about 60 thousand tons will be increased to 300 thousand tons in the coming five years. To attain this target, the government is hoping to increase the cropping area in districts (3) to (5).

Though the northeastern district is situated in a politically important area, the subsistence-level agriculture conducted in the district holds the farmers on a poor financial footing. To improve and stabilize farm economy in this district, introduction of suitable cash crops that can take place of kenaf is essential.

Since the demand for kenaf has already reached the limit, its sales price fluctuates largely by a slight change in the demand-supply balance. It is therefore planned that soybeans will be grown in the kenal producing area by rotation including kenaf or in place of kenaf. If introduced in the kenaf producing area, soybeans will be cultivated in the rainy season so as to make use of rainwater.

The dry season soybean cropping in the northeastern district, the the soil condition of which will be described later, calls for the consolidation of upland field irrigation facilities. Though the estimated irrigable area in the district is as wide as about 600 thousand rai, satisfactory irrigation facilities are found only in about 3 thousand rai. Therefore, rainy season cropping in upland fields will be given higher priority.

Researches and experiments also indicate that rainy season cropping should be given priority over dry season cropping. However, to provide for the future introduction of dry season cropping, it will be necessary to make studies on soybean cultivation in the dry season.

The yield of paddy is 130 kg/rai, which brings about a gross income of about B 150/rai. In 1971 when the rice export showed a decline, however, the gross income from paddy cultivation is considered to have alsoddropped to about B 70/rai. In contrast with this, soybeans promise a gross income of B 300/rai from a yield of 150 kg/rai and are therefore more commendable than paddy for improvement of farm economy.

In the central high land, i.e., the maize producing area in and around Saraburi, green beans and sorghums are cultivated as the rainy season second crops after the rainy season first cropping of maize to prevent the decline of soil productivity due to continous maize cropping. Soybeans introduced in this area will take the place of green beans and sorghums for establishment of a rotation system involving maize and soybeans. With about 300 tractors already introduced in this area, it is considered feasible to set up a mechanized and integrated cultivation system of mize and soybeans and materialize large scale soybean production.

Dry season soybean cropping is planned as the succeeding cropping of paddy currently produced in and around Chainat of the central high land. This plan will have to be implemented by extensive application of agricultural machines and equipment without following the traditional farming practices.

As described above, soybeans are cultivated in different areas in Thailand. The cultivation conditions in these areas such as temperature, rainfall and day-length vary largely because of the difference in the cropping season. This means that both cultivation and breeding of soybeans in this country involve great diversity of problems that must be brought to light.

With Mae Jo Agricultural Experiment Farm selected from among a number of farms as the basis of their activity, the Japanese experts are now engaged in breeding experiments including artificial crossing and breeding of resultant progencies as well as in yield ability test and selection of introduced varieties and are providing, at the same time, advices and guidances to Thai counterpart workers.

In addition, the yield ability test of introduced varieties is being carried out at Kalasin Seed Farm and in the fields of experiment farms at Utong, Srisamrong, Tachai and Prabudhabahat, whereas line test and part of individual selection test are conducted at the farms at Srisamrong and Roi-Et. Various cultivation tests are also performed in close cooperation with the counterpart workers. Further, tests have been conducted at Kalasin Seed Farm on the sowing season of the dry season (1970) soybeans.

Details of these tests and experiments will be described later in this report. Mention must be made here of the need for delineating the scope of application of the data obtained at Mae Jo Farm because both the cropping season and enviromental conditions vary by district as explained earlier.

2. Studies and Experiments for Improvement of Cultivation Techniques

Japan's past cooperation in various studies and experiments conducted since the rainy season of 1970 and its future research cooperation plan are shown by item in the following table.

Description and Place of Tests and Experiments by Cropping Season

Year	Rainy Season	Dry Season
a. Sowing Season Test		
1970	Conducted by Thai side.	Mae Jo and Kalasin.
1971	Mae Jo.	Ditto.
1972	Mae Jo (completed).	
b. Planting Density Test		
1970	Conducted by Thai side.	Mae Jo.
1971	Mae Jo.	Ditto
1972	Mae Jo and other farms.	Mae Jo and other farms.
	* Sowing season x planting density (including differences by district).	* Sowing season x planting density (including differences by district).
1973	* Ditto (planned to be completed).	* Ditto (planned to be completed).
c. Weeding Test		
1970	Mae Jo	Mae Jo
	* Effect of time and frequency of intertillage on yield.	* Test on the applicability of herbicides.
	* Paddy field plowing method and amount of weeds.	
	* Test on the applicability of herbicides.	

Year	Rainy Season	Dry Season
1971	* Test of promising herbicides	* Test of promising herbicides
1972	* Continuation of above test.	* Continuation of above test.
.		
.		
.		
1975		

d. Germination ability Maintenance Test of Soybean Seeds.

1970	Mae Jo.	* Mae Jo and Bangken.
	* Collection of specimens (21 varieties).	* Preservation condition test.
1971	* Survey of changes in germination ability of seeds produced in the dry season.	
	* Underground preservation and germination ability of seeds produced in the 1970 dry season.	
1972	* Confirmation of preservation conditions for maintaining high germination ability.	* Same as the left column.
.		
.		
.		
1975	* Clarification of factors of varieties exhibiting high germination ability.	* Same as the left column.

e. Fertilization Test

1970	Mae Jo.	Mae Jo.
	* Test of fertilization effect of SJ2 and Japanese varieties.	* Same as the left column.
1971	* Conducted by Agricultural Chemistry Division with consideration given to differences between districts.	* Same as the left column.
.		
.		
.		
.		
.	* Test of top-dressing method.	* Same as the left column.

f. Survey of Insect and Disease Damages

1970	* Heavy damages of stem miners and the genus of stink bags confirmed by the survey of actual cultivation condition.	* Same as the left column.

1970	* Occurrence of namatode, rust, and virosis confirmed.	* Same as the left column.
1971 . . .	* Intensity of damages confirmed throuth the survey of actual cultivation condition.	* Same as the left column.

g. Survey of Root Nodule Bacteria

1970	* Adherence of root nodule bacteria confirmed to vary by district and variety.	* Same as the left column.

h. Soil Moisture Test for Dry Season Soybean Cropping.

1971		* Survey of water requirement. * Relationship between soil moisture and growth and yield. * Sowing method and irrigation system.

i. Survey of Actual Cultivation Condition of Soybeans.

1970	* Survey of cultivation condition in major wet season cropping areas.	* Survey by interviews with 200 farm householders in Chieng Mai Province.
1971	* Survey of cultivation, cropping system and growth condition of soybeans grown by farmers in Sukhothai and Chieng Mai provinces. * Yield judgement per unit area.	* Yield judgement per unit area.

3. Tests and Experiments for Breeding New Varieties.

a. Tests on Introduced Varieties

In time with the commencement of the project in 1970, varieties introduced into Thailand prior to that time, varieties and strains bred or introduced in Japan and preserved at various places, and about 1,500 varieties and strained imported from all over the world were collected. These varieties and strained have been put to test cultivation and comparison for selection of most suitable ones.

The test plan of introduced varieties is shown in Table 1.

The test results so far obtained indicate that strains bred in Taiwan include some very suitable ones which, however, are noted to be handicapped by unsatisfactory dehiscent characteristics.

The test results also show that Japanese varieties generally present a smaller vegetative growth than in Japan due to the difference in day-length and temperature and have the drawback of getting dehiscent easily.

b. Utilization of Existing Varieties.

As regards SJ1, SJ2 and other varieties for which multiplication and extension are planned for the present, the problems of fixation and admixture of other varieties still remain unsolved. However, the pure line isolation carried out so far produced fairly successful results, reaching the stage of multiplying seeds of suitable varieties.

Table 1 - Test Plan of Introduced Varieties

(Number of Test Varieties and Test Places)

Year	Number of Introduced Varieties	Number of Selected Varieties	Preliminary Yield Ability Test	Yield Ability Test	Test of Character-istics
1970R	362	45			
1971 D	1,395	48	50 (Mae Jo. Kalasin)		
1971 R			45(Mae Jo)	31 (5 locations)	20 (Mae Jo)
1972 D			30 (Mae Jo) Kalasin	25 (3 locations)	10 (Mae Jo)
1972 R			20 (Mae Jo Srisam-rong)	20 (6 locations)	10 (Mae Jo)
1973 D				20 (3 locations)	10 (Mae Jo)
1973 R				20 (6 locations)	10 (Mae Jo)

1) R- rainy season, D - dry season.

2) Tests are completed up to the wet season of 1971.

3) Test of characteristics includes the test of fertilizer dosage, test of planting density and test of sowing period (with special reference to the suitability of late sowing).

At present, soybeans belonging to same varieties are grown in both the dry and the rainy seasons. Since the test results indicate that SJ1 is suited for rainy season cropping and SJ2 for dry season cropping, differentiation of varieties suited for either season is planned for the present. This plan, however, calls for the consideration of a seed production system and preservation of seeds.

c. Breeding of New Varieties by Artificial Crossing.

At time of starting the project, it was anticipated that the breeding by artificial crossing would entail many difficulties. However, as a result of preliminary experiments on the conditions of artificial crossing, i.e., time of crossing, selection of mating stocks, capacity of pollen mother cell, meteorological conditions and so forth, some combinations of artificial crossing proved successful in the 1970 rainy season, which was ensued by the breeding of F1 in the 1971 dry season, and with experiments continued thereafter, breeding up to F3 has been attained so far.

The success of this artificial breeding deserves high evaluation in that it made the breeding of new varieties very promising and also aroused the attention of Thai people towards the breeding techniques. In artificial crossing thus far conducted, combinations of major Thai varieties and Japanese varieties and combinations of promising strains bred in Taiwan and Thai varieties constituted the major part. These combinations, intended to breed varieties having a larger grain size and yield and improved quality, produced some promising individuals in F3 and are hoped to bring about a successful result.

Breeding of new varieties by artificial crossing is planned as shown in Table 2.

As described already, there are large differences in the environmental conditions such as day-length, temperature and soil moisture under which the dry season and rainy season soybeans are placed during their growth period. These differencesare taken into due account in selecting individuals bred by artificial crossing. For example, each combination of mating stocks is chosen after determining the cropping season, and selection or experiments are planned to be conducted concentrically for that season while acceleration of generations is planned to be given prime consideration for other seasons.

d. Breeding System

In the past breeding activities, artificial crossing and selection of F1 were carried out at Mae Jo Farm in the north, preliminary yielding ability test at both Mae Jo Farm and Kalasin Seed Farm, and yielding test at Srisamrong Farm and Prabudhabaht Farm. Though the existing breeding system is considered basically suited for the future need, the party is of the opinion that local tests should be augmented by gradually increasing test with the progress and enlargment of the experiment work.

Table 2 - New Variety Breeding Plan by Artificial Crossing

Year		Crossing (mating)	F1 (mating)	F2 (mating)	F3 (mating stock)	F4 and on ward	Preliminary Yielding Ability Test	Yielding Ability Test	Characteristic Test	Performance Test at Farmer's Field	Variety Preservation
1970	R	30	8								
1971	D	3	-	6							
	R	-	2	10	3 (500)						
1972	D	2	-	2	5 (800)	3 (300)				5(4 loc)	○
	R	3	3	3	2 (300)	8 (700)				5(6 loc)	
1973	D	3	3	3	3 (300)	10(500)	50			5(8 loc)	○
	R	3	3	3	3 (300)	13(450)	50		10	5(8 loc)	
1974	D	3	3	3	3 (300)	15(500)	50	15(5 loc)	10	5(8 loc)	
	R	5	5	3	3 (300)	15(500)	50	15(6 loc)		5(8 loc)	

Notes: 1) R - Rainy season; D - dry season.

2) Tests completed up to the rainy season of 1971.

3) Preliminary yielding ability test to be conducted at Mae Jo and Kalasin.

4) Characteristic test to be conducted at Mae Jo.

5) In addition to the tests shown above, the following tests were carried out in the rainy season of 1971.

1. Survey of affinity between the root nodule bacteria and soybean varieties in the northeastern district (at Rai-Ed).

2. Survey of fluctuation and difference between varieties by sowing period (at Mae Jo).

II. EXISTING PROBLEMS

1. Problems in Cultivation Techniques.

a. Suitability of Mae Jo Farm.

The greater part of tests and experiments for improving the cultivation techniques is carried out, as described already, at Mae Jo Experiment Farm in Chiang Mai province. To the extent that Japan's research cooperation will be offered by the experts currently stationed in Thailand, it is advisable that tests and experiments be conducted concentrically at Mae Jo Farm because this farms allows tests to be carried out in both rainy and dry seasons (the farm's irrigation facilities cover part of its upland fields) for one thing, and provides the service services of the counterpart workers and technicians for another.

However, since the delineation of the scope of applicability of test results obtained at this farm matters greatly to the future extension of cultivation techniques, it is imperative to establish a system under which the services of counterpart workers specialized in soybeans will be made available at experiment and seed farms in respective areas and the soybean cultivation techniques will be improved for confirmation of the outcome of efforts made at Mae Jo Farm.

b. Individual Problems.

Under the traditional farming practices, the sowing period of dry season soybeans in the norther districs lasts from late December to February, whereas the tests reveled that the highest yield can be achieved by sowing in mid-January. As regards the rainy season varieties, tests are now in progress.

In the case of the rainy season soybeans cultivated in the northeastern district, sowing in mid and late May ensures the best growth, but this sowing period is claimed to make difficult the harvesting and assurance of quality because the maturation period coincides with the rainy season. These problems, however, are assignable to the traditional harvesting method, and can be solved by constructing simple storehouses that can shut out rain and by using threshers at suitable times.

The planting density varies largely by farm household. Rainy seasons are given to explain this. One of them is the extremely low germination ability of seeds, and the other is the fact that about 10 grains of seeds are sown for wet season cultivation because heavy rains immediately after sowing make the surface layer hard and exert repressive effect on the germination ability. At present, therefore, more seeds than actually required are sown to the financial disadvantage of farmers, and this occasionally brings the number of plants per hill to excess, causing extremely poor growth of individual plants. Solution of this problem calls, among all other things, for the availability of seeds having a germination rate of 90% or more. In this connection, the tests on the maintenance of germination ability are of great significance.

Upland fields in Thailand are subject to the heavy growth of weeds which is characteristic of warm areas. In the rainy season, weeding is difficult either by human labour or by machines. Insofar as the farm households visited by the party are concerned, all the fields were covered with weeds excepting the intercropping area in the central upper plain.

The herbicide adaptability test conducted for the dry season disclosed that the highest weeding effect is displayed by a dosage of 500 cc/rai of lasso (43.7) and 2.5 kg/rai of Lasso (10), followed by the application of 320 cc/rai of MO 388 (in quantity of elements; stabilized against temperature change), 200 g/rai of Lorox (50) (in quantity of elements; liable to incur some spray injure when water is logged), and 200 cc/rai of Treflan (44.5) (also in quantity of elements).

Farmers following the traditional farming practices do not usually apply any fertilizers. The observation made at Mae Jo Farm during the fertilization test revealed that a high fertilizer effect is demonstrated even if the dosage of additional fertilization is equivalent to that of base fertilization. In the rainy season when fertilizers are likely to be carried away by rainwater, it is advisable to apply them over a number of times by dividing the predetermined dosage.

In the northeastern district, some varieties presented complete lack of adherence of root nodule bacteria, and to clear up the cause of this phenomenon, experiments were conducted by experts on soybeans growth in the 1971 rainy season.

As a result, it was revealed that the adherence of the said bacteria is noted on SB60, a local veriety, but not at all on SJ1 and SJ2, and this adherence condition showed no changes when all these varieties were planted in a single hill. This clearly indicates, as has long been recognized in Japan, that there exists a varying affinity between different races of root nodule bacteria and different varieties of soybeans.

The role played by the root nodule bacteria in the cultivation of soybeans is very well known, and any attempt to cover all the nitrogen requirement in the growth period with fertilizers is just too inefficient and not acceptable. Hence, it is of controlling importance to clarify the affinity between the bacteria and soybeans and discover those races showing a high affinity with SJ1 and SJ2 for which extension and seed multiplication are planned.

It is considered that studies on this subject will necessitate the service of an additional Japanese expert specialized in the said bacteria who will work in cooperation with the breeding and cultivation experts.

c. Mechanized Cultivation of Soybeans.

From the existing technical level of farmers, it is believed that mechanized soybean cultivation on the farmer's level will be difficult excepting the plowing and soil preparation works. Considering, however, that the right farm work should be conducted at the right time to expand the cropping area as planned and that soybeans are hoped be introduced as the succeeding crop in the maize producing area of the central high land and also as the rainy season second crop after harvesting paddy, it leaves no doubt that large farming machines should be employed for the preparation of seed beds.

2. Problems in Breeding Plan.

a. Introduced Varieties.

Since introduced varieties have not yet been fully studied for cultivation in the rainy and dry seasons, their extensive application as mating stocks calls for continued experiments and adaptability tests in major soybean producing areas. In breeding soybean varieties to be grown in Thailand in future, paramount consideration should be given to the assurance of not only stabilized and high yield rate but also excellent quality(yellow hilum color, medium grain size, and high nutrient content). Accordingly, mating stocks having all these characteristics should be made available.

Substantially large numbers of varieties have so far been introduced from other countries, but collection of varieties should be continued specially from areas lying at about the same latitude as Thailand with due account taken of the seed preservation. Further, segregation and fixation of suitable varieties included in the introduced varieties should be promoted since the preliminary yielding ability test disclosed that some of such introduced varieties are not fixed or are subject to the admixture of other varieties.

b. Breeding by Artificial Crossing.

The breeding work may be considered to have been set well afoot. However, the one expert currently stationed in Thailand cannot be expected to bear all the workload of differentiating varieties for the dry and rainy seasons. If additional experts are assigned, division of breeding work by purpose or district will become possible and the breeding of varieties will be largely prompted.

c. Breeding System.

Concentration of breeding work at Mae Jo Farm is considered reasonable. However, since this farm is located in the dry season soybean producing area, selection of breeding stocks should also be carried out at farms in the rainy season soybean producing area. In this connection, it is desirable that the selection of early filial generations partly conducted at Srisamrong Farm at present be expanded in scale.

Further, in view of the strong desire for introducing soybean cultivation in the northeastern district, the breeding system should be so improved that the selection of early filial generations will be carried out in the said district. It is to be noted, however, that the breeding tests in the northeastern district must be preceded by the improvement of soil conditions which are extremely unsatisfactory.

The yielding ability test and local test should be carried out in as many areas as possible differing from each other in soil and meteorological conditions, irrespective of the weight carried by soybeans in the agriculture of respective areas.

It is known that in the rainy season of this year, sowing was made impossible in some areas due to drought. It is therefore desireable that irrigation facilities be made available for rainy season soybean cropping.

d. Root Nodule Bacteria.

Non-adherence of root nodule bacteria is one of the major problems in the northeastern district. Since the experiments so far conducted have succeeded in selecting, from among local varieties, a few individuals showing the adherence of the bacteria, experiments on the affinity between the races of the said bacteria and soybean varieties should be carried out at an accelerated pace in close coordination with the experts specialized in soil and soil microorganisms.

e. Breeding of Resistant Varieties

Introduction of resistant varieties against rust will be required in future because of the frequent occurrence of this disease in the central high land and northern district. It is reported that experiments are being made in Taiwan, though not in a large scale, for breeding varieties resistant against rust. Date of these experiments should be obtained and used in making studies on resistant genes.

It is preferable that similar studies on resistant genes be planned for other major diseases.

f. Seed Multiplication.

While the Department of Agricultural Extention is responsible for the multiplication and distribution of seeds, Department of Agriculture is in charge of pure line and original seed multiplication which is carried out at experiment farms and seed farms.

Seed production in future should be promoted in cooperation with breeding experts in areas selected to achieve as high a multiplication rate as possible.

It is preferable that the staffs responsible for the maintenance of seed farms and preservation of seeds be given adequate training and education. If a seed multiplication and distribution system is established with the necessary legislative measures take for its smooth function, it will doubtlessly contribute to the future multiplication and distribution activities.

g. Elevation of Technical Level of Breeding Staffs.

Though the training and other guidance activities provided in the past have resulted in the noticeable improvement of technical level of breeding staffs, it is necessary to establish a training system which will enable these staffs to be assigned to the breeding work for a substantially long period.

h. Securing of Breeding Field.

A sufficient area should be secured for the breeding field with efforts also exerted to make the soil condition both improved and uniform so as to be able to cope with the expected sharp increase in the quantity of stocks available for breeding experiments.

3. Problems in Insect and Disease Control.

No particular tests have been conducted in the past on the control of insects and diseases. However, in the course of cultivation and breeding tests and in the process of extending improved cultivation techniques among farmers, it was recongized that the future development of soybean cultivation in Thailand hinges on the establishment of insect and disease control techniques. This recognition was achieved by the realization that soybeans grown in this country are often affected by virus diseases, rust and other diseases and also subjected to heavy damages caused by many different kinds of insects. Particularly, the genus of stink bugs which show frequent outbreaks from the podding stage to the ripening period are considered to be probably the most dominant cause of sterility. It was also often reported that the occurrence of leaf rollers developing throughout the growth period and stem miners that eat into the heart of main stem had been on the steady upward tend.

Though the clarification of actual occurrence condition of these major insects and diseases was one of the items planned to be covered by the present itinerant survey, actual survey activity was confined, due to the limited time available, to the confirmation of their occurrence condition already reported by Thai experts.

As a result of this survey, 15 species of the stink bugs were detected to be parasitic on soybeans, of which Nezara viridula (Linne) and Cletus pungnator (Fabricius) recorded the largest number of individuals at all survey points and were consequently confirmed to be the dominant species. Nezara viridula (Linne) is distributed from the temperature zone to the tropical region all over the world and its occurrence in Japan takes place in the southern part of Honshu island, Shikoku, and southern part of Kyushu. As it inflicts damages on both soybeans and paddy, it is an important species. Its paratisism on soybeans from the podding stage to the pod hilling stage results in total sterility or grain deformation and soiling.

Insects generally called leaf rollers indicate those insects of Order COLEDPTERA (such as Tortricides, Gelechidae, Noctuidae and Pyralidae) whose larvae have the leaf rolling characteristic. Four species belonging to this group, i.e., Cacoecia micaciana Wkr., Stomopteryx subsecivella Zell., Lamprosema indica F., and Lamprosema diemenalis Geun., were identified by the past surveys, and damages likely to have been caused by them were observed during the present survey in various districts. Heavy damages attributable to these insects were found in survey districts in northern Thailand, whereas the damages in the northeastern Thailand were rather light due perhaps to the fact that most of the fields surveyed belong to experiment farms and are therefore given good maintenance care. Damages caused by insects of Tortricidae appear quite heavy at the first glance, but the rate of damaged leaves in ostensibily heavily damaged fields rarely exceeds 10%. It is estimated that damages caused by Tortricidae are actually far less heavy when compared with the damages incurred by the genus of stink bugs. Stem miners were noted to have a substantially high rate of parasitism at all survey points. Observation made by cutting the main stem of damaged plants disclosed that many larvae eat into the heart, indicating that stem miners give a considerable repressive effect on the growth of soybeans. In the reports on Thai experts, the stem miner is identified as Agromyza phaseori Coq., of Agromyzidae. If this assumption is correct, the stem miner in Thailand belongs to the same species as soybean stem miner in Japan (presently applied scientific name: Melanagromyza phaseoli (Coquillett) which is distributed in Kyushu and considered to inflict damages particularly on autumn soybeans.

Though its ecology has yet been hardly studied,,this species deserves detailed and specialized study because of its importance for soybean cultivation in Thailand.

As for soybean diseases, development of the mozaic disease (a virus · disease) and rust is most problematic, and it was strongly felt that their control measure should be established. It was learned that the development of the mozaic disease is known to vary by soybean variety. According to Thai experts, occurrence of this disease on encouraged varieties is conspicuous with Pakchong and SB-60. It is reported that grains affected by this disease are found in harvested soybeans of these two varieties.

The main issue in this disease is the discovery of the shrinkage symptom. There are some Thai experts who do not support the opinion that the symptom is to be attributed to the virus transmission. Though aphides can be generally cited as the vectors. Empoasca sp., a kind of small green leafhoppers, was suspected as the vector since its heavy occurrence was detected during the survey in the fields of Mae Jo Farm.

The rust disease has shown so limited a development in Japan in recent years that it is no longer considered a major soybean disease. In Thailand, however, it affects soybeans quite heavily and cautions are exercised against the recent upward trend of its development. Chemicals effective for the control of this disease have not yen been developed, but since its development appears to vary by variety, it is hoped that the disease will be eventually be controlled by the breeding of resistant varieties.

The following measures will have to be taken in the future control of insects and diseases.

(1) Efforts should be made not to resort to chemicals alone.

(2) Studies should be made to avert the damage by breeding resistant varieties and by applying suitable cultivation techniques.

(3) Control measures should be taken only for these insects and diseases eradication is considered necessary from the analysis of damages.

(4) If chemicals are to be applied, the minimum required amount of those chemicals exhibiting a low toxic effect and low residual toxic effect should be used.

(5) Constant attention should be paid to the effect of natural enemies.

(6) Efforts should be directed towards establishing an integrated control method.

Note: It is considered that restrictions will be soon placed on the application of chlorine chemicals in Southeast Asian countries. Prudent consideration should be giben to the extension of control techniques using chemicals because fishes caught in paddy fields and creeks in the rainy season are the important source of animal protein in these countries.

III. FUTURE COOPERATION IN SOYBEAN PROJECT

As described already, the soybean project in Thailand involves many problems, of which the most important would be to increase the number of Japanese experts because of the reasons given below.

(1) As manifested in its third Five Year Plan, the Thai government has the intention to accelerate the development of the soybean project.

(2) The Thai government is also hoping to promote soybean cultivation in the northeastern district.

The augmented services of Japanese experts are an imperative if the Japanese government is to seriously push forward its technical cooperation in the project. Despite of the short survey period, the survey results point to the acute need for increasing Japanese experts, and this was supported by the Japanese experts in Thailand specialized in other fields.

Considering the fact that the number of Japanese experts now stationed in Thailand is limited to only three specialized in breeding, cultivation and marketing respectively, and that the Thai technical level is not sufficiently high, it will be extremely difficult to render cooperation services to the satisfaction of Thai government in the extensive project area embracing the northern district, central high land and northeastern district.

It will therefore be necessary to dispatch the experts listed below for the establishment of a satisfactory cooperation system. This proposition should be studied between the governments of Thailand and Japan.

To make the guidance activity more fruitful and effective, the Japanese experts will have to stay at a same place constantly and carry out research and guidance activities in close cooperation with each other. Establishment of a soybean research centre at a suitable place like Mae Jo Farm in the major soybean producing area would greatly enhance the effect of guidance activity. In this case, however, due consideration should be given to the maintenance of close contact with the Thai authorities. In other words, since most of Japanese experts will be working at the soybean centre, an adviser, acting as their leader, should be stationed at the Department of Agriculture to maintain close contact with it. The adviser will also be required to maintain contact with the centre and ensure smooth contact and coordination within the Department of Agriculture and between the Department of Agriculture and other government offices and further take part in the drafting of plans for the project implementation.

1. 2 Experts Specialized in Breeding (for long-term stay).

It goes without saying that the breeding work should preferably be performed in an integrated manner by individual experts because it requires a long-term continous work from the selection of individuals bred by artificial crossing to line breeding. However, dispatch of experts over along period is next to impossibility because it involves the problem of their status after return to Japan. To prevent any delay in the breeding work arising from the shifting of experts, it is proposed that a certain time lag be made in the service period of the two experts so that both will be enabled to work together for a year.

The technical cooperation in seed multiplication and distribution is to be extended by breeding experts, and the proposed dispatch of two experts will meet this purpose. If two experts cannot be stationed in Thailand, the new expert should be dispatched at least 1.5 to 2 months before the return of the old expert for the transfer of breeding work.

2. 2 Experts Speciallized in Cultivation Techniques (for long-term stay).

The project area is very extensive as already described, and mere cultivation experiments cannot be expected to bring about a solution for the problem of poor soil condition in the northeastern district to which great importance is given by the Thai government for future soybean production. The project area need to be divided into two areas, i.e., one embracing the northern district and upper central plain and the other covering the northeastern district and central high land, for concentric research activities in respective areas.

3. 1 Expert Specialized in Soil and Fertilizers (for long-term stay).

Dispatch of this expert is considered indispensable for fertilization and land improvement in the northeastern district where the soil condition is extremely poor.

4. 1 Expert Specialized in Root Nodule Bacteria (for short-term stay).

Dispatch of this expert will be necessary to clarify the affinity between the root nodule bacteria and soybean varieties grown in the northeastern district.

5. 1 Expert Specialized in Agricultural Machinery and Equipment (for short-time stay).

The soil condition in Thailand is considerably divergent from that in Japan and therefore, agricultural machines and equipment employed in Japan cannot directly put in use in Thailand. The many large type machines already offered by Japan need an overall check to ensure their full utilization in the project area.

6. 1 Plant Protection Expert (for long-term stay).

As described already, measures should be established as soon as possible for controlling diseases and insects causing sterility of soybeans, particularly for genus stink bugs whose frequent occurrence is observed in all districts and the stem miner which is known to eat into the stem and cause poor growth. Control of these insects and diseases calls for basic studies into their life history and pattern of their damages.

7. 1 Expert Specialized in Marketing (for long-term stay).

Dispatch of this expert is necessary for more detailed study of the problems in marketing mechanism, distribution economy and demand-supply trend which are considered to be retarding the export of soybeans.