FEASIBILITY STUDY REPORT

ON

RICE PEST FORECASTING AND CONTROL PROJECT

IN

THE REPUBLIC OF INDONESIA

FINAL REPORT

OCTOBER 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of the Republic of Indonesia, the Government of Japan decided to conduct a feasibility study on the Rice Pest Forecasting and Control Project and entrusted the study to the Japan International Cooperation Agency. The J.I.C.A. sent to Indonesia a survey team headed by Mr. Mitsuo Yoshimeki from February 2 to March 30, 1982.

The team exchanged views with the officials concerned of the Government of the Republic of Indonesia and conducted a field survey in eight Provinces covered by the Project. After the team returned to Japan, further studies were made and the present report has been prepared.

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

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

October, 1982

Keisuke Arita
President
Japan International Cooperation Agency

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SUMMARY

Project Priority: Striking increases in rice production in Indonesia have been recorded annually over the past years mainly due to the intensification of rice production through the introduction of high yielding rice varieties since the commencement of the nationwide BIMAS/INMAS Programme. However, although the Programme was expected to result in an annual rice production total of 30 million tons, production for 1980 was recorded at 28 million tons. Consequently, approximately 2 million tons of rice had to be imported to provide a sufficient rice supply.

One of the major factors causing the production gap between actual and potential yield is pest damage, a problem to which little attention has heretofore been given. The implementation of adequate pest control under a network system of pest forecasting and control will not only reduce pest damage but also will serve to decrease the foreign currency budget for agricultural chemicals and staple foods to be imported, thus strengthening the national economy.

In this regard, strengthening and expanding the pest forecasting and control programme in Indonesia is the priority component of the national effort to increase rice production and thereby foster self-sufficiency in staple foods and to provide balanced income distribution for the farmers.

Purpose and Strategy: To contribute in coping with the national problem of securing ample production of staple foods, a Feasibility Study on the further development and strengthening of the Food Crop Protection Programme was carried out. Said Study undertook a field survey, examined the existing nationwide plant protection system, and finally formulated an overall development plan model for the Food Crop Protection System which included a delineation of the proposed pest forecasting and control system, its function, and a staff education and training programme.

To implement the above Study, the Feasibility Study Team was fielded from January 28 to March 30, 1982. The Team's mission was to (i) collect information and data on pest forecasting and control, (ii) study local conditions concerning major pests and related environmental factors, (iii) inspect the existing system and facilities of the national Food Crop Protection Scheme, (iv) study current farm practices, and (v) identify rural socio-economic conditions in the provinces concerned.

Location and Scope: The Project area for strengthening the food crop protection scheme in Indonesia encompasses the provinces of Aceh, South Sumatra, Lampung, South Kalimantan, South Sulawesi, East Java, Central Java and West Java.

A master plan was drawn up, incorporating the comprehensive functions of Directorate of Food Crop Protection as the mainstay of the national system, Food Crop Protection Center as the nucleus of each local system, Forecasting Laboratory/Protection Brigade as embodying the technical functions of the system, and Pesticides Laboratory as a reliable support institute for practical pest control. The master plan also included a formulation of necessary facilities, equipment, and education/training programmes towards improvement of administrative, technological, and educational aspects of pest forecasting and control programme.

Beneficiaries: Efficient implementation of Food Crop Protection Scheme would produce widespread benefits for the nation of Indonesia.

A timely pest control operation would release farmers from unnecessary application of pesticides and expenditure thereby incurred, and would accordingly amplify total incomes with an increase of crop yields.

The local populace in general would benefit from a rise in rural socio-economic levels through the increase of incomes from agricultural production and rectification of the deteriorating inter-regional economic balance.

By increasing crop yields, the Project would serve to reduce the nation's continuing import of staple foods and production materials, and consequently serve to promote a more favorable balance of international payments. Imported agricultural production materials now employed for the cultivation of staple food crops could be efficiently appropriated for other useful agricultural crops. An effective pest forecasting and control system would promote achievement of the priority objectives of the national agricultural development programme, i.e., self-sufficiency in staple foods and rectification of disparities in inter-regional levels of agro-economic development.

Improved international and domestic marketing situations resulting from the increase in staple food crop production would positively stimulate the infrastructure development of other sectors of trade, finance, education, transportation, etc., thereby widely apportioning the benefits of the Project throughout the national economy.

Main Components: Principal components covered in the master plan are (i) construction of building and facilities, (ii) equipment improvement, (iii) smooth integration of all elements of the pest forecasting and control scheme, (iv) programming of the education and training plan for involved personnel at all levels and (v) project evaluation. However, technical education and training, one of the most functionally important components of the proposed scheme, is to be implemented in collaboration with the existing Plant Protection Project (ATA 162).

Development Period: Although the master plan is intended for implementation as a five year development plan from commencement of the Project, 20 years or more would be required for full realization of the effects of the proposed forecasting and control programme throughout the entire rice production area of the target provinces. However, subsequent 2nd and 3rd five year phases of the development programme would witness considerably shortened periods for materialization of Project benefits.

Cost Estimates and Anticipated Financing: Total cost for implementation of the master plan is estimated at US $48 million, which would be financed in both local and foreign currencies.

Economic Justification: Based on the economic advantages to be derived from efficient execution of the forecasting and control programme, an economic benefit analysis of the Project was made at current prices.

The EIRR has been calculated on the basis of the direct costs and benefits, and is estimated at 22.82 percent.

Sensitivity tests were also conducted to determine the impact of several adverse contingencies on the economic feasibility of the programme. These include *inter alia* increase of operational costs by 10% and the failure to adequately transfer the high yielding technical knowlege to the farmers.

On the basis of the above analysis, the Project is considered to be economically justifiable.

I. Introduction

To cope with the increasing national population and rising rice consumption per capita, the Indonesian Government has embarked on programmes to increase food crop production. The principal objectives of these programmes are to attain national self-sufficiency in staple foods and redress inter-regional disparities in levels of agro-economic development. In this light, the government has promoted food crop protection systems towards efficient intensification of agricultural production. The BIMAS/INMAS Programme afford striking evidence of the effectiveness of implementing the following priority components for high yield cultivation: (i) introduction of high yielding rice varieties, (ii) generous fertilizing practices, and (iii) efficient use of irrigation water. However, the production gap between actual and potential yields has remained, and in 1980 it was accordingly necessary to import 2 million tons of rice.

The level of rice yield depends on numerous factors, such as climatic and soil conditions, management of available irrigation water, fertilization, rice variety, cultivation practices, plant protection, distribution and marketing, etc. In the case of BIMAS/INMAS Programme, objectives of high yield production initially appeared to be achieved within the early phase of programme implementation. However, during subsequent stages the programme encountered problems in the form of unanticipated pest damage to crops. Although the pest population was reduced by means of chemical application and the introduction of resistant rice varieties, repeated chemical use over successive cropping seasons induced the emergence of resistant pest species as well as destroying natural enemies thereof. As a result, the pest population began to regenerate with pest damage worsening year by year. This conventional method of chemical application has also altered the existing bio-ecosystem within the paddy field, causing proliferation of pests which heretofore had not been problematic. Consequently, pest control efficiency has steadily decreased, with eventually serious production losses anticipated.

The Indonesian Government authorities recognized that one of the major factors causing the gap between anticipated and actual yields has been inadequate pest control through over-emphasis on the use of conventional pesticides on rice in Indonesia. The Directorate of Food Crop Protection has been accordingly founded with the objective to strengthen the food crop protection programme, although results have fallen short of programme expectations. Accordingly, the Government has requested agricultural development assistance from the Japanese Government for the Rice Pest Forecasting and Control Project which comprises surveillance and monitoring of major pest species, assessment of pest damage, criteria for pest control, pest control technique, dissemination of information in relation to control operations and back-stopping research results, and administrative organization.

In earlier times, Japanese rice culture was based on the small farmer and in many ways was therefore similar to the present situation of rice farming in Indonesia today. Based on the steady efforts of the farmers, who developed their own incentives for increased rice production, and with the administrative support of the Japanese Government and collaboration of research institutes, technology for stable, high yielding rice cultivation was successfully developed in Japan.

Specific components of effective pest control include the capacity to accurately predict pest species, period/peak date of pest appearance, and numerical abundance of pests, all based on continuous observation through monitoring, surveillance and assessment of pest damage. A national rice pest forecasting programme has been in effect in Japan since 1941 which features a nationwide network system conforming to standards expressed in the ministerial publication "Guidelines for Enforcement of the Pest Outbreak Forecast". From the time that the above programme went into effect in 1941, a substantial amount of pest forecasting and control related information and data has accumulated, which has lead to further improvements in the system.

The Japan International Cooperation Agency (JICA) exchanged the signed minutes of the scope of works for the Feasibility Study with concerned officials of the Indonesian Government on February, 1982. The principal objective of the said Feasibility Study was to formulate a master plan for the proposed Project, and under the provisions of the scope of works the Study was conducted in Aceh, North Sumatra, Lampung, South Kalimantan, South Sulawesi, East Java, and West Java provinces with the close cooperation of the Directorate of Food Crop Protection. On the basis of field study findings, a master plan for the Rice Pest Forecasting and Control Project was formulated at the Consultants' home office. Said master plan is applicable to the Project area provinces - Aceh, North Sumatra, South Sumatra, Lampung, South Kalimantan, South Sulawesi, East Java, Central Java and West Java - and accords ample consideration to the existing national food crop protection scheme.

Team members of the field study on the Rice Pest Forecasting and Control Project in Indonesia and the counterpart personnels of the Indonesian Government who cooperatively supported the study are as follows.

Advisory Mission:

Mr. Toshio Morita	Mission Leader
Mr. Tohru Sasaki	Rice Pest Control
Mr. Takeo Endo	Rice Pest Forecasting
Mr. Yoshiyuki Ban	Project Evaluation

Study Team:

Dr. Mitsuo Yoshimeki	Study Team Leader
Mr. Shoji Masumura	Deputy Team Leader Agro-economics, Agro-statistics
Mr. Masayoshi Shibata	Agronomy
Mr. Kunihiro Kawachi	Rice Entomology and Plant Pathology
Mr. Fumio Wada	Agricultural Chemistry
Mr. Setsuzo Kikkawa	Agro-economics
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Counterpart:

Dr. I. N. Oka Director,
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Mr. Soedoso Head of Administration Division
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II. Background

A. The Country and its Characteristics

Indonesia is an island nation situated at the southern extremity of Southeast Asia, straddling the equator for 2,000 km from north to south and 5,000 km from east to west. The nation comprises Sumatra, Kalimantan, Sulawesi, Java, West Irian and other islands totalling some 13,700 in all and encompassing a land area of 190 million ha. This total land area in turn consists of 114 million ha of forest land (60% of the total), 15 million ha of arable land (8%), 13 million ha of waste land (7%) and 48 million ha of other various types of land (25%).

Climatically, Indonesia falls within the tropical rain zone. The country experiences a wet season from October to March and a dry season from April to September, although seasonal climatic differences are not marked. Mean temperature is 26°C, mean diurnal temperature range is 8°C, mean relative humidity is 80%, and mean annual rain fall is 2,630 mm. Localized variations in precipitation patterns are, however, evident to some extent from region to region.

The national population in 1980 was 147 million. As population has been increasing yearly at the rate of 2.3%, the national population is expected to be more than 210 million by the year 2000. While the overall average population density of Indonesia is 77 persons per km^2, 65% of the total population is located on Java Island (7% of Indonesia's total land area) where the population concentration is 691 persons per km^2. To remedy this situation, the Government implemented a transmigration policy to move a portion of the population from Java Island and resettle them on the extensive, yet sparsely populated, arable lands of Sumatra (population density of 59 persons per km^2), Sulawesi (55 persons per km^2), Kalimantan (12 persons per km^2), Irian (11 persons per km^2), etc. The objectives of this resettlement programme have been largely unachieved due to inconvenient living situations in the target areas resulting from lagging local agricultural, social and economic development.

B. Current National Economic Situation

Due to recent progress in the development of the petroleum industry in Indonesia, the relative weight of the agricultural sector within the national economy has decreased, despite sizable agricultural yields. Nevertheless, Government efforts to establish self-sufficiency in staple foods and to rectify regional differences in agro-economic development through the three 5 year plans implemented since 1969 have fallen short of programme growth targets. Although a socio-economic growth rate of 4.6% was anticipated, actual growth has remained at 3.4%.

Major components in increasing rice yield are development and expansion of cultivable paddy field, and improvement of the ha-yield. Based on statistics contained in the FAO Production Year Book (1976, 1978, 1980), the total area under rice cultivation has expanded yearly to 9 million ha by 1980, which is 1.3 times the amount indicated in the 1961 - 1965 Government statistics. The FAO estimate of rice yield per ha was 3,187 kg in 1980, or 1.8 times that recorded in the 1961 - 1965 statistics. Therefore, a total rice yield of 28.7 million tons was produced in 1980 according to FAO figures, which is 2.3 times the amount cited in the 1961 - 1965 statistics of the Indonesian Government. Due to the population growth rate of 2.3% per annum, 1.9 and 1.8 million tons of rice had to be imported in respective 1977 and 1978 to meet domestic rice consumption levels. Rice consumption per capita, 125 kg/year in 1980, has steadily increased and is strongly expected to reach 150 kg/year in the near future, which will make the Government's objective of self-sufficiency in rice all the more difficult to attain.

On the other hand, total rice yielding loss caused by rice pests in Indonesia is estimated at approximately 6 million tons annually (19% of the total yield) which is equivalent to 3 times the amount of imported rice per year. Furthermore, although BIMAS/INMAS Programme through intensive agriculture produced better ha-yields in project areas than the national average (2.32 tons in 1978 and 2.38 tons in 1979 in programme areas in as opposed to national averages of 1.96 tons and 2.02 tons for the same years respectively), the generous fertilizer and pesticide applications in the course of the cultivating high yielding varieties ultimately induced heavy incidences of rice pest damage in the programme areas.

It was concluded that one of the major factors causing the production gap between actual and anticipated yields was the failure to prevent pest damage through adequate pest management. In response thereto, the Indonesian Government decided to embark on a policy of strengthening its Food Crop Protection System through incorporation of pest forecasting and control components.

C. Importance of Staple Food Crops in the Economy

The agricultural sector in Indonesia accounts for 32.2% of the Gross Domestic Product (GDP) attributable to the industrial structure. This is well ahead of the commercial, manufacturing, and mining sectors which occupy respective shares of 16.4%, 12.9% and 10.5% respectively. Indonesia is the 3rd largest rice producing country in the world, and as such food crop production constitutes 58% of the agricultural sector output.

Over 70% of the total population is settled in rural areas, where 61.5% of the nation's active labor force (over 10 years old) is employed in the agricultural sector.

Of the 19 million ha of arable land in Indonesia, 9 million ha is paddy. The amount of land cultivated per individual farmer averages less than 1 ha, and farming operations are therefore generally small scale in nature. However, 6 million ha of arable land (39% of the total arable land area) is concentrated on Java Island where 61% of all rice in the nation, 83% of all soybeans, 75% of all corn, 75% of all ground nuts, and 74% of all cassava are produced through intensive agricultural practices. Due to the high food crop production of Java farmers, agro-economic development levels are higher on Java than in other areas of Indonesia.

Arable land in Indonesia in 1979 totalled 19 million ha. Although an additional 40 million ha is estimated as cultivable, only 1.4 million ha has been developed over the past 10 years. Furthermore, whereas rice ha-yield on Java Island is as high as 2.32 tons, that in other areas of Indonesia averages only 1.69 tons. As a result, the expansion of extensive arable land in areas outside of Java is being prioritized as the increase of cultivable land on Java is approaching its limitations.

In 1980, rice production reached 28 million tons which is roughly 2.3 times the annual production total recorded during the 1961 - 1965 Government statistics. However, due to increasing population and rice consumption per capita approximately 2 million tons of rice had to be imported in 1980 at a cost of US$ 573 million. In addition, it was also necessary to import fertilizers valued at US$ 150 million as well as pesticides worth US$ 42 million.

Utilizing the Government's transmigration policy to secure the necessary agricultural labor population, arable areas outside Java Island could be effectively expanded to bring rice production in line with domestic consumptive demand and increase farmer incomes. This would serve to achieve Indonesia's goal of self sufficiency in staple food production as well as to rectify regional imbalances in agro-economic development.

D. Present Approach to the Problems

Regardless to what extent the Indonesian Government has employed intensive BIMAS/INMAS Programme to create stable high yield of rice by means of introduction of the high yielding rice varieties and generous fertilizer application, the production gap between actual and potential yields has remained.

Research results demonstrated that cultivation of high yield varities in combination with generous fertilizer application resulted in heavy pest infestations. Rice pests proliferated in BIMAS/INMAS Programme areas due to exposure to calendered pesticide application and/or introduction of resistant rice varieties without operation related technological information. Consequently, pests resistant to applied pesticides have increased, secondary pests have emerged, bio-types independent destructive pests have occured and useful natural control agents have been destroyed.

As mentioned before, production increase of staple food crops, rice in particular, is the priority government policy in Indonesia. To increase rice yield, the following measures are deemed appropriate.

1. Expansion of paddy

Expansion of paddy rice produces appreciable yield in total, despite low ha-yield. As ha-yields of paddy rice and upland rice are 3.58 tons and 1.41 ton respectively, expansion of paddy field rather than that of upland rice field has priority.

2. Development/adjustment of irrigation facilities
   Rice ha-yield increases through maintenance of necessary irrigation water, and appropriate water management.

3. Introduction of rice double cropping
   Limited land may be cultivated twice or more during a single year to produce more rice in total than single cropping, if irrigation water is available all year round. Irrigated rice culture in the dry season produces higher yield than rain-fed rice culture in the wet season.

4. Introduction of high yielding rice variety and generous fertilizing culture
   The majority of high yielding varieties require generous fertilizer application to exhibit genetic high yielding characteristics. Such measures increase the ha-yield on one hand, yet generate pest outbreak on the other hand. In addition, the high yielding variety has poor cooking quality.

5. Others
   An improvement of physical/chemical properties of paddy soil introduces better ha-yield through maximum utilization of potential productivity of the soil.

The above-mentioned measures serve to increase the ha-yield. In parallel with this phenomenon, the measures produce an alternative agro-ecosystem which generates pest out breaks. The resulting yield loss of 6 million tons of rice cannot be ignored. Thus, efficient/adequate pest control measures reduce pest damages and indirectly result in increasing the ha-yield.

To ensure economical and effective pest control and information on pest species, outbreak period and/or peak date of appearance abundance of pest species, the most appropriate control measure are needed. In this regard, continuous observations must be carried out on the biology and ecology of pest species and their natural enemies, assessment of pest damage and control practices.

Accordingly, a comprehensive master plan incorporating systems and functions towards smooth implementation of pest forecasting and control is appropriate for the existing food crop protection scheme in Indonesia.

III. Agricultural Development Strategy and Project Concept

A. Agricultural Development Programme

The two agricultural development programmes in close relationship to strengthening of the food crop protection system, which is the priority policy in increasing food crop production in Indonesia, are "Strengthening of Plant Protection Service Project (ATA-162)" and "Development of Rice Crop Protection Center in Indonesia (ATA-259)".

ATA-162 aims to promote rice pest control capabilities in Indonesia through the following activities.

1. Studies on rice pests at Forecasting Laboratory, Jatisari
2. Biological research on rice pests at Central Research Institute for Agriculture (CRIA), Bogor
3. Analytical works of pesticides at Pesticide Laboratory, Pasarminggu
4. Programming of an annual operational plan and issuance of technical advice for food crop protection at Central Office, Pasarmminggu
5. Information exchanges on specimen and research findings, upgrading the capability of involved personnels in food crop protection, and other related activities

ATA-162 has been in progress since January 1981 as a JICA technical cooperation project.

ATA-259 aimed at improvement of rice crop protection activities in 8 target Provinces (Aceh, South Sumatra, Lampung, South Kalimantan, South Sulawesi, East Java, Central Java, and West Java), consists of the following project activities.

1. Strengthening the Directorate of Food Crop Protection
2. Establishment of Food Crop Protection Center, Forecasting Laboratory and Pest Observatory Unit
3. Supply of vehicles to insure mobility of project activities
4. Supply of equipment for the Directorate of Food Crop Protection, Food Crop Protection Center, Forecasting Laboratory, and Pest Observatory Unit
5. Training of staff and workers to upgrade their capabilities

Both ATA-162 ATA-259 and are cooperation projects designed to establish a rational pest forecasting and control system, which is one of the major factors in obstructing the attainment of increasing rice production. Along the abovementioned lines, the Indonesian Government has requested technical cooperation and development assistance from international donor agencies.

In response to this request, JICA has carried out a Feasibility Study (F/S) entitled "Rice Pest Forecasting and Control Project" from January, 1982 on the basis of Record of Discussion (R/D) between Japanese and Indonesian authorities on "Cooperation for Increasing Rice Production in Indonesia", agreed to on June 1, 1981. The F/S is directed towards the improvement of the rice crop protection scheme in the target Provinces. On the basis of field study, the said F/S subsequently set out to:

- formulate model systems for rice pest forecasting and control applicable to various agronomic conditions,
- prepare an overall development plan for a rice protection service in the target provinces based on the model systems formulated above,
- formulate a project training programme for staff and workers, and
- generate an implementation schedule for the overall development project.

B. Project Concept

Experience in advanced countries have demonstrated that successful pest forecasting and control schemes contribute to saving appreciable amounts of yield which would otherwise be lost. Therefore crop protection based on systematic forecasting and control activities is amply justifiable in terms of its potential role in helping the Indonesian Government to attain its goal of self sufficiency in staple food through increasing staple food crop production and in preventing pest damage, which amounts to as much as 6 million tons of rice annually.

Taking into consideration the development plan formulated by the Indonesian Government and the Scope of Works (S/W) agreed to between the Japanese and Indonesian agencies concerned, the following components were recognized as important for implementation of a cooperation programme which would effect functional operation of the planned pest forecasting and control system.

1. Functional organizational structure: To carry out integrated duties on forecasting and control at central and local levels, the existing structure

was reviewed and a plan was formulated to effect the optimum organizational structure.

2. Buildings and related facilities: Proposed working space necessary for involved personnel was prepared by the concerned institutes (Food Crop Protection Center, Forecasting Laboratory, Pest Observatory Unit, Crop Protection Brigade and Pesticide Laboratory).

3. Equipment: Proposed equipment required by involved personnel in executing their assigned tasks were prepared by the concerned institutes, (Directorate of Food Crop Protection, Food Crop Protection Center, Forecasting Laboratory, Pest Observatory Unit, Crop Protection Brigade, and Pesticide Laboratory).

4. Communication system: While the telephone communication system in Indonesia has made striking progress in recent years, dependance on the existing telephone system would still result in inconveniences given the large information excharge and dissemination requirement of a nationwide pest forecasting network. Provision of an alternative facility (Telecopier) was accordingly suggested.

5. Training, education, workshop, extension: To upgrade working capabilities of involved personnel, training, education, workshop, and extension programmes at various levels were suggested.

6. Demonstration: To educate farmers in the importance of crop protection in production, generate farmer's active participation in the Project, and draw farmer's attention to crop protection for all crops in general, a demonstration farm was suggested.

7. Cooperation among other specific fields of agriculture: Incidences of crop pests are influenced by many technological production related factors. Therefore, cooperation among other agriculture related fields of agronomy, breeding, agro-meteorology, soil sciences, irrigation, plant physiology, and agricultural mechanics was suggested.

8. Research institutional collaboration: Basic technical support is essential to operate field and laboratory works. Collaboration among research institutes

and a proposed programme to receive back stopping research results from the various institutes concerned were advised.

9. Other activities: Other activities unexpectedly found to be important, and where mutually agreed by the involved authorities, will be considered in due course.

The present master plan was thus formulated incorporating the above items.

C. Identification of Project Area

The rice pest forecasting and control programme is to be executed under a nationwide network system. However, Aceh, South Sumatra, Lampung, South Kalimantan, South Sulawesi, East Java, Central Java and West Java have been agreed to as priority project provinces in that the Indonesian Government expressed its strong desire that the project focus on these 8 Provinces due to the quantity of rice production in the areas and their importance in the rice economy. Characteristics of the target Provinces are briefed hereunder.

- Aceh and South Sulawesi: Based on 1979 Statistics, the ha-yield of rice in these provinces are 2,879 kg and 2,875 kg, respectively, and levels of rice cultural technology are moderately advanced. Because of relatively scarce population, the abundant surplus rice is shipped to provinces where rice is in deficit.

- South Sumatra, Lampung, and South Kalimantan: Based on 1979 Statistics, the ha-yields of rice in these provinces are 2,303 kg, 2,421 kg and 2,202 kg, respectively, a low level in comparison with the national average at 2,985 kg. High rice production is recognized as potentially attainable through increasing both the ha-yield by means of improvement of production practices and total yields by means of additional expansion of paddy land. These 3 provinces are expected to be major rice stock provinces in the future.

- East Java, Central Java, and West Java: Based on 1979 Statistics, the ha-yields are as high as 3,852 kg, 3,241 kg, and 3,245 kg, respectively. Levels of rice cultural technology are high and intensified rice culture is being practiced therein. Due to such intensification, rice pest problems are strikingly evident, and efficient implementation of rice pest forecasting and control is accordingly urgently needed in these provinces.

Taking into consideration the above-mentioned situations of each project province, the proposed location of Food Crop Protection Center and its responsible province are tabulated in Table 1.

IV. Plan for Field Study Operation

A. Objectives of Field Study

The objectives of the study conformed to the mutually agreed S/W, were

1. to prepare a general and integrated plan to decrease the rice pest damage in the object provinces in collaboration with the Plant Protection Project (ATA-162), and
2. to undertake on-the-job training to transfer the technology to counterpart personnel in the course of the study.

B. Study Schedule

The study was conducted with the following aims:

1. to study the local condition of the major rice pests,
2. to inspect existing facilities and systems of the national food crop protection scheme,
3. to study current farm practices, and
4. to identify local socio-economic conditions.

The study has been worked out from January 28 to September 27, in 1982 and divided into three successive working phases, preparatory home office works, field study and finalizing home office works, respectively.

(a) Preparatory home office work

The preparatory home office work was conducted from January 28 to February 1, 1982 prior to the field study in accordance with JICA's guideline for the proposed study. During this period, collection of related informations by those responsible for field works and preparation of a specific working plan were made. By close consultation with the team members, the "Plan of Operation" for the study was prepared.

(b) Field study

Based upon mutual agreement between Indonesian and Japanese authorities, and upon the "Plan of Operation", the field study was conducted from February 2 to March 30, 1982 in rice producing areas of Aceh, North Sumatra, Lampung, South Kalimantan, South Sulawesi, East Java, and West Java provinces. The study team members reviewed conditions and gathered relevant data from the view point of their specialized/responsible fields at each candidate area on

1. agro-meteorological conditions
2. soil conditions
3. rice pest conditions and control measures
4. education, training and extension programmes
5. current farm practices
6. activities of Directorate of Food Crop Protection, Food Crop Protection Center, Forecasting Laboratory, Pest Observatory Unit and Crop Protection Brigade
7. activities in pesticide inspection
8. roles of research institutions
9. mobility and information dissemination / exchange, and
10. socio-economic conditions

Summary of the field study is provided in the "Progress Report" of the study.

(c) Finalizing home office work

Based on the results of the field study and the data collected, the following home office works were conducted in Japan from May 18 to September 27, 1982:

1. completion of the field study,
2. preparation of the master plan on rice pest forecasting and control scheme,
3. preparation of the training programme for the involved personnel,
4. determination of the economic evaluation, and
5. preparation of the implementation schedule of the Project.

Overall home office works mentioned above were conducted from May 18 to August 7, 1982, aimed at preparing Draft Final Report of Feasibility Study on the Rice Pest Forecasting and Control Project.

A spot presentation meeting on the Draft F/S Report was subsequently held at the Directorate of Food Crop Protection, Pasarminggu, Jakarta from August 22 - 28, 1982.

Taking the comments of Indonesian and Japanese authorities into consideration, final home office works were conducted to amend/incorporate these comments into the Draft F/S Report, and finally draw up the Final F/S Report on the Rice Pest Forecasting and Control Project in the Republic of Indonesia.

V. Result of Field Study

A. Meteorological Conditions

While rice cultivation depends on temperature, solar radiation, sunshine and precipitation, one of the major limiting factors of rice production in the tropics is annual precipitation. On the other hand, distribution, abundance, and behavior of the pest species and their predators and parasites are influenced by the climatic conditions, such as temperature, humidity, evapotranspiration, precipitation, wind and day length of which one or more of these conditions are involved. Agro-climatic factors thus play an important role in the agricultural production system, however there is insufficient data which pays attention to the relationship between agricultural production and the climatic factors in the tropics.

Distribution of 158 meteorological stations attached to the Weather Bureau is marked in Fig. 1. At each station, precipitation, temperature, humidity, atmopheric pressure, velocity and direction of wind and solar radiation are regularly observed. At additional 165 meteorological stations, the same observations are carried out, and further 2,380 observatory stations observe precipitation only. It is understood from the figure that the majority of the meteorological stations are concentrated in Java island. Due to the damage of some meteorological observation equipment, only approximately 160 stations are functioning properly. The results of these observations are annually published in the Climate Data (DATA IKLIM DI INDONESIA) and the Rain Observation (PEMERIKSAAN HUDJAN) of Indonesia.

The Central Research Institute for Agriculture (CRIA) maintains 22 agro-meteorological stations in Java, Sumatra, South Kalimantan and South Sulawesi (Fig. 2) to observe precipitation, temperature, humidity, evapotranspiration, velocity and direction of wind, solar radiation and sunshine. Observed results are published every 3 months in the Agro-climatology. With some damaged observatory equipment, however, only 9 stations are fully operational.

(a) Mean temperature

Annual mean temperature is 26°C. It is understood from Table 2 that the monthly temperature range is very narrow (1.8°C in average) even though the monthly temperature range was relatively wide in Banda Aceh, Jakarta, Bandung, Surabaya and Denpasar in 1977, normal values with narrow ranges are evident in 1978. This condition seems to indicate that the annual change of mean temperature is more evident than the local specificity of the change.

(b) Mean maximum temperature

It is noted from Table 3 that the extremes of the daily maximum temperature recorded at Ujung Pandang and Bandung, the highland were 38.8°C and 28.7°C, respectively. Usually, the daily maximum temperature observed at the other stations fell to 30.0°C - 33.0°C with relatively small annual fluctuation.

(c) Mean minimum temperature

Table 4 indicates that the relatively low daily minimum temperatures ranged from 15.0°C - 18.8°C and 17.3°C - 18.9°C with respect to 1977 and 1978 at Bandung, the highland, while the daily minimum temperature at other stations fell to 21.5°C - 23.3°C with relatively small annual fluctuation.

For rice growth, 2,400 degree days of the accumulated temperature is required. Based on this, there is no evidence of shortage of solar energy in Indonesian rice culture so long as the mean temperature is 26°C and the growth period of rice varieties cultured is over 120 days. While the temperature range positively accelerates rice yield under the temperate conditions, such may not happen in Indonesia where the temperature range is very limited.

(d) Monsoon

Indonesia is situated at the equatorial monsoon zone where wind blows from the west in December, January, February and March, and from the east in June, July, August and September according to (Fig. 3 and 4). Such a characteristic monsoon influences agro-meteorological conditions, precipitation in particular.

(e) Precipitation

Precipitation in 1977/1978 is shown in Table 5. Due to the monsoon, distinctive wet and dry seasons are recognized in Indonesia, and the following 3 areas are clearly identifiable.

1. Area evident of wet and dry seasons (Yogyakarta, Surabaya)

2. Area not evident of wet and dry seasons (Banda Aceh, Medan, Padang, Pakanbaru, Jambi, Bengkulu)
3. Area intermediately evident of wet and dry seasons (Jakarta, Bandung, Tanjung Karang)

However, conditional differences between the wet and dry seasons in Indonesia is moderate due to appropriate rain fall during the dry season which is extremely different from the climatic condition of continental Southeast Asia.

For optimal rice growth, 1,800 mm of the annual precipitation is required. The rain fall in the mountainous areas is held in the soil, gathered into the river system which eventually contributes to the agricultural production in the respective river basin areas. Accordingly, it is noted that the annual precipitation at 1,000 mm level is apparently sufficient for rice cultivation. It is observed from Table 5 that the annual precipitation at Banda Aceh and Yogyakarta was below the 1,800 mm level but exceeded the 1,000 mm level. Therefore, it can be concluded that the precipitation in these areas is normally adequate for single rice cultivation.

Relationship between area distribution of the annual precipitation and rice cultivation in Indonesia is classified statistically. High rice yield has been recorded in every successive seasons in Java where generous precipitation is observed. For further details, basic studies on water percolation in the soil, water runoff, soil water holdings, evapotranspiration, etc. are needed to clarify the relationship between the water balance and rice yield in paddy cultivation.

(f) Humidity

The average relative humidity is 79.8%. It is understood from Table 6 that the annual humidity range is rather wide at Ujung Pandang, Bandung, Surabaya, Semarang and Banda Aceh, however, that of the rest of the stations does not fluctuated throughout the year. This means that there is moderate precipitation even in the dry season.

(g) Sunshine duration

The sunshine duration is influenced by some of the meteorological factors, type and amount of cloud in particular, and accordingly varies annually, monthly and diurnally. It is observed in Table 7 that the sunshine duration of the dry season is long in Jakarta, Bandung, Surabaya, Denpasar and Ujung Pandang, but at the other stations it is stable at 59.8% in average. This means that sunshine during the wet season is abundant under similar conditions. The solar radiation is sufficient for rice growing in Indonesia.

B. Pest Conditions

As the duration of this field study was too short, necessary long-term paddy field observation on rice pest incidences was impossible. In addition, the majority of rice growing stages observed during the field study were in the state of harvest, and severe damages caused by brown plant hopper and field rats were found in only a few paddy fields without any generous infestation of other rice pests. Accordingly, the following considerations on annual fluctuations and seasonal prevalences of rice pests is based on the existing data and information collected during the present field study.

(a) Annual fluctuation

Economically important rice pests in Indonesia are listed on Table 8, 9 and 10. Acreage of rice pest damage in 1978 and 1980 are tabulated by province in Table 11 and 12, respectively. It is understood from these tables that the common important pest species in the major rice producing areas in Indonesia are rice borers, gall midge, brown plant hopper, rice bug, army worms, leaf rollers, rice black bug and green rice leaf hopper. In comparison between 1978 and 1980, damaged acreage caused by army worms increased, on the contrary, that caused by rice borers, gall midge, brown plant hopper, and rice bug decreased. Relative abundances of rice borers and leaf rollers increased and that of brown plant hopper decreased in 1980.

Relative abundance of damaged acreage caused by the major rice pests in the object provinces of the Forecasting and Control Project in 1978 and 1980 are tabulated in Table 13 and 14, respectively. Comparison between the two tables concluded in the following.

1. In general, it was concluded that the total acreage of rice pest damage reduced to half in 1980 mainly due to the reduction of the brown plant hopper population, and that, as far as the relative abundance of pest damage was concerned, rice borer damage increased while the damage of the brown plant hopper decreased.

2. Banda Aceh

Total acreages of rice pest damage decreased in 1980. Relative abundance of rice borers, army worms and leaf rollers increased while that of brown plant hopper decreased in 1980.

3. North Sumatra

Total acreage of rice pest damage was not substantially different with each other. Relative abundance of rice borers decreased while that of brown plant hopper increased in 1980.

4. West Sumatra

Total acreage of rice pest damage was not marginally different from one area to the other. Relative abundance of the rice borers, rice bug, and leaf rollers decreased while that of the brown plant hopper and rice black bug increased in 1980.

5. South Sumatra

Total acreage of rice pest damage reduced extremely in 1980 mainly due to decreasing brown plant hopper population. Relative abundance of rice borers increased while that of the rice bug decreased in 1980.

6. Lampung

Total acreages of rice pest damage was not substantially different from area to area. Relative abundance of rice bug and army worms decreased while that of the leaf rollers increased in 1980.

7. West Java

Total acreage of rice pest damage reduced to about half in 1980. Relative abundance of rice bug decreased while that of army worms and leaf rollers increased in 1980.

8. Central Java

Total acreage of rice pest damage reduced to about half in 1980. Relative abundance of rice borers and leaf rollers increased while that of the brown plant hopper decreased in 1980.

9. East Java

Total acreage of rice pest damage reduced to as low as one third of 1980. Relative abundance of rice borers, gall midge and brown plant hopper decreased while that of rice bug, army worms, and leaf rollers increased in 1980.

10. Bali

    Total acreage of rice pest damage reduced in 1980. Relative abundance of rice borers, rice bug, and leaf rollers increased while that of the brown plant hopper decreased in 1980.

11. South Kalimantan

    Total acreage of rice pest damage reduced slightly in 1980. Relative abundance of rice borers, rice bug, and leaf rollers decreased while that of the brown plant hopper increased in 1980.

12. South Sulawesi

    Total acreage of rice pest damage varied a little within the area. Relative abundance of rice borers, army worms, and leaf rollers increased while that of the brown plant hopper decreased in 1980.

The major rice pests intended for control in the object provinces of the Project in 1978 and 1980 are mapped on Fig. 5 and 6, respectively. From these figures, major control-oriented rice pests requiring forecasting were recognized.

Meanwhile, major rice pests were charted by Kabupaten in Banda Aceh, North Sumatra, and Lampung and are shown in Fig. 7, 8 and 9, respectively. From these figures, location specifically characterized by major pest species by each Kabupaten was found, in other words, target species for forecasting and control varied from Kabupaten to Kabupaten.

Brown plant hopper population increased with the cultivation of high-yielding rice varieties, IR-5, C4-63 and Pelita, peaking from 1974 -1977. Thereafter, the population decreased as resistant varieties, such as IR-26, IR-28, IR-30, IR-32 and IR-36 were increasingly cultivated in every successful year. However, such beneficial resistant varieties do not occupy more than 60% at a ceiling percentage of rice growing areas in Indonesia given the poor cooking quality of the varieties.

Annual changes in occurrence of rice borers, brown plant hopper and rice bug and of acreage of brown plant hopper resistant rice variety cultivated from

1973 - 1981 in South Kalimantan are shown in Fig. 10. The following is interpreted from the figure.

1. In 1973, rice borers broke out but a substantial reduction in population is witnessed in the following year. The population gradually increased towards 1976 with subsequent decline since.

2. From 1973 - 1975, the rice bug multiplied numerously and then gradually decreased in number.

3. From 1975 - 1977, the brown plant hopper multiplied numerously with subsequent population decrease as the brown plant hopper resistant variety was increasingly cultivated.

Annual changes of organized Crop Protection Brigade in number are shown in Fig. 11. Judging from these figures, a negative correlation between brigade number and pest population is apparent.

(b) Seasonal prevalence

- Rice borers: White rice borer (Tryporyza innotata), yellow rice borer (T. incertulus) and striped rice borer (Chilo suppresalis) were found to be prevalent in Indonesia. Monthly light trap catches of these 3 species which CRIA carried out in East Java are shown in Fig. 12. From the figure, the followings are found to be evident.

  1. Each species has its own seasonal prevalence, i.e., in general, rice borers are abundant from March - April and September - October, while yellow rice borer are abundant from March - April, the other two species were abundant in September - October.
  2. The number of rice borer generations was not evident.

  Furthermore a few other detailed field observations have been recorded separately on the species, therefore, a specific training programme for rice borer identification is needed.

- Brown plant hopper: Results of the comparative studies on three different field observation methods - light trapping, insect net sweeping and water-pan trapping - are carried out at the Food Crops

Research Institute, Sukamandi, and are shown in Fig. 13. From the figure, the followings are observed.

1. The brown plant hopper was trapped numerously from February-April and July-September which corresponds to the harvesting of rice.

2. The individual number of brown plant hopper and the period numerously trapped, varied from location to location and year by year, apparently due to annual change of brown plant hopper population and seasonal prevalence corresponding to the non-synchronize rice culture.

3. As each growing stage of rice existed continuously, generations of brown plant hopper overlapped with each other. Therefore, the number of generations was not clear, but it is apparently 9 - 10.

- Gall midge: Light trap catches of gall midge which were carried out in East Java by CRIA from the 1975 - 1976 season are shown in Fig. 14. From this figure, 12 generations can be recognized in a year. The gall midge was most abundant from February - April and August - October. Research results showed that the gall midge multiplies numerously 40 days after rice transplanting. In this regard, young rice of the vegetative growth should be abundant in the paddy prior to these two periods.

C. Pest Control

Rice pest control in Indonesia has been carried out by pesticide application and introduction of resistant rice varieties. Cultural control and/or biological control which utilize natural control factors/agents have been examined, evidencing that applicable techniques for pest control in practice have not been developed. A comprehensive integrated rice pest control programme has been excellently implemented on an experimental basis in South Sulawesi.

(a) Pesticides

In Indonesia pesticide application for rice pest control has been achieved under the BIMAS/INMAS Programme. Pesticides prepared for the BIMAS/INMAS Programme are shown in Table 15. It is noted from the table that 37 insecticides, 4 fungicides/bactericides and 5 rodenticides among 46 pesticides in total were prepared, and 39 (85%) were liquid formulation and 7 (15%) were granule.

Distribution of pesticides in percentage is shown by province in Table 16. The followings are apparent from the table.

1. The majority of the pesticides prepared was distributed to Java island.
2. In the case of Java island, distribution of Jakarta and Yogyakarta is low due to the small acreage of paddy in both provinces.
3. In the case of Sumatra, the distribution is high in North Sumatra, Lampung and South Sumatra.
4. In the case of Sulawesi, the distribution is high in South Sulawesi.
5. In the case of outer Java, Bali had a high amount of distribution even though the total acreage of paddy is small.

Distribution of insecticides, fungicides/bactericides and rodenticides is shown by province in Table 17. This table shows that the majority of the distributed pesticides is insecticides followed by rodenticides, while fungicides/bactericides is extremely limited except in Java island. Moreover, the amount of pesticide distribution varied season by season in accordance with rice pest abundance. Judging from the above-mentioned phenomena, provinces troubled by rice pests are identified as follows.

1. In the case of the Sumatra: Banda Aceh, North Sumatra, South Sumatra and Lampung.
2. In the case of Java: All provinces
3. In the case of Sulawesi: South Sulawesi
4. In the case of other outer areas: Bali

Distribution of pesticides by the registered name was shown in Table 18. It is noted from the table that Diazinon 60 EC (Basudin 60 EC), Dusban 20 EC and Sevin 85 SP are in great demand in BIMAS/INMAS Programme followed by Agrothion 50 EC, Azodrin 15 WSC, Elsan 60 EC, Elstar 45/30 EC, Hopcin 50 EC, Lebaycid 550 EC, Sumibas 75 EC, Sumithion 50 EC, Thiodan 35 EC and Trithion 4 E. In 1980, however, the demand of Basazinon 45/30 EC, Brantasan 450/300 EC, Dimecron 50 SCW, Elstar 45/30 EC, Emulthion TM and Mipcin 50 WP increased.

(b) Resistant variety

One of the major components of the rice production increase policy since 1960 is an introduction of improved rice varieties. While the Cere line improved rice varieties - Bengawan, Sigadis, Remaja, Pelita and Dara - became popular in the 1960s, Pelita line improved rice varieties - Asahan, Brantas, Citarum, Serayu, Cisadane and IR line ones-IR-26, IR-32, IR-36, IR-38 and Semeru - became popularized in the 1970s. Recommended resistant rice varieties against appropriate rice pests are shown in Table 19 and 20. Rice varieties resistant against brown plant hopper were cultured extensively in brown plant hopper infested areas. However, good quality rice varieties, Asahan, Citarum, Cisadane and other local varieties with good cooking quality, in particular, are preferred varieties.

D. Cultural Condition

As seen in Table 21, as a result of the rice yield increasing policy in Indonesia, BIMAS/INMAS Programme occupies over 60% of the total paddy by 1977. Thus, the rice cultural technology has been extended quickly in parallel with implementation of the national BIMAS/INMAS Programme. In comparison between 1961 - 1965 and 1980, the national average ha-yield, the acreage of rice culture and the total rice yield increased from 1.76 ton/ha to 3.19 ton/ha, from 7,036,000 ha to 9,000,000 ha, and from 13,396,000 ton to 28,680,000 ton, respectively (Table 22). Introduction of the improved high yielding rice varieties and improvement of fertilizer application have contributed to such striking rice yields increasing. Improvements of water management, raising of seedling and cooperative rice pest control have also contributed to increase production output in limited rice production areas.

(a) Cultural Practice

1) Introduction of improved rice varieties

There are Bulu and Cere lines of the native variety in Indonesia. While Cere lines were cultivated mostly in the 1960s, they have been replaced by IR lines. However, pest resistant native varieties, Brantas, Serayu, Citarum, Asahan and Cisadane are favored to paddy due to their good qualities, while the seed of Cisadane in particular is marketed at a relatively high price because it is favored by local consumers. Bulu lines were common in Bali, Lombok and fertile mountainous/high land areas in Java, South Sulawesi and South Sumatra where pest damage is minimal. As improved Cere lines are highly photo sensitive, they are cultivated only in the wet season. In practice, Cere lines - Cisadane, Citarum, Semeru - are cultivated in the wet season and IR lines (IR-36, -50, -52) are grown in the dry season. Since the native varieties are susceptible to rice pests, in comparison with IR lines, rice culture of the native variety is prohibited.

2) Seed selection and seed treatment

Seed selection is carried out at the Seed Production Centers. The majority of seeds at the centers was contaminated, with the seed at Lampung Center the best among all centers studied where wind selection was conducted as much as 3 times.

No seed treatment was seen. Practicing of seed soaking and hastening of germination was reported in East Java Province.

3) Green manure

Seeds of green manure crop have been distributed, but the distribution was stopped after the commencement of BIMAS/INMAS Programme.

4) Crop rotation

Due to popularization in culturing the early matured IR variety rotaion cropping has expanded under the active network system of the agricultural extension service throughout the country. Typical examples of the locally adopted crop rotation at Cidarjo, East Java are as follows.

- Example 1. Sugarcane (16 months) - sweet potatoes (4 months) -soybeans (3 months) - Bali putih rice (5 months) - Bali putih rice (5 months) - Bali putih rice (5 months), 38 month interval

- Example 2. Sugarcane (16 months) - IR rice variety (4 months) - soybeans (3 months) - IR rice variety (4 months) - soybeans (3 months) - IR rice variety (4 months) - soybeans (3 months), 37 month interval

Experimental studies on a 36 month rotation cropping system have been carried out at Food Crop Research Institute, South Kalimantan, and are presently in the experimental phase.

Rice monoculture with 3 croppings during a 2 year period and/or 5 croppings during a 3 year period was very common in South Sulawesi. Accordingly, other experimental studies on continuous rice culture with alternative rice pest resistant varieties for the purpose of integrated rice pest management were carried out at Food Crop Research Institute, and obtained results challenged attentions for present practices.

5) Fertilizer application

Fertilizer mainly depended upon chemical materials of Indonesia, but no green manure and compost were to be seen during the present field study. In Lampung Province, even the upland rice received 3 fertilizer applications at seeding period, one month and two months after transplanting.

Amount of fertilizer applied varied from location to location, but was mostly applied at the rate of 200 kg/ha of urea, 100 kg/ha of triple superphosphate (TSP) and 20 kg/ha of Pottasium chloride, respectively, while the standard rate of BIMAS Programme. Paddy received urea at the rate of 300 kg/ha yielded 9 ton/ha in East Java, on the other hand, that which received the same amount of urea yielded only 6 ton/ha in Banda Aceh. Both paddy of East Java and Banda Aceh reported an increase in rice pest population under such generous N-fertilizer application conditions. Pottasium chloride, however, was not applied in general, and pottasium sulfide (ZA) was sometimes applied to the sulpher deficient soil.

Urea was applied three times at transplanting period, one month and two months after transplanting. TSP was applied once at the transplanting period. Normally during fertilizer application, provision of irrigation water is not recommended, however, no such evidence of this practice was reported during the present field study. Moreover, in some cases nursery received no fertilizer at all, while the recommendation is at the rate of 3 -4 kg of fertilizer for one ha of rice seedlings.

6) Pesticide application

BIMAS Programme recommends two times application at the rate of 1 kg/ha or 1 l/ha for each treatment. It is recorded that some farmers apply 8 applications of pesticides during the rice growing period. Then again other farmers do not use pesticides even though pesticide application is common. Still, further often pesticides were applied only when pest infestation was observed, and in such cases, the application was too late for effective pest control.

7) Soil amendment

No evidence of application of the soil conditioner, such as lime, was observed. As TSP contains lime, continuous TSP application to the phosphoric deficient soil apparently contributes to soil amendment. In practice, urea is abundantly/extensively applied but TSP is applied at the under rate below the 100 kg/ha under the BIMAS Programme.

Firing of rice straw was observed in the paddy field after harvest, however, purpose/efficiency of the firing straw was not ascertained.

8) Water management

Water management plays an important rôle in increasing rice yield. By 1979 irrigation facilities thus developed covered 59.6% of the total paddy areas, while the remaining paddy was rain fed, swampy or very low land unfit for irrigation water.

At the rice transplanting period, different rice growing stages, vegetative, generative and harvesting can be observed. Water in the nursery beds was not adequately managed, therefore, the majority of the nurseries were submerged.

9) Farm mechanization

Various spray equipment were extensively/effectively used. Tilling works were mainly depended upon cattle tillage even there where exists a contract tilling service by the government and/or private own tractor.

10) Raising of seedling

Low land rice nurseries with flat seed-beds are most common, while a few narrow rice-nurseries can be observed. In general, 30 - 40 kg of rice seeds were prepared for one ha seedling, while the BIMAS Programme recommends at rate of 25 kg. Heterogeneous seedling in the nursery bed was frequently observed. And nursery days of improved and native rice varieties were 20 and 30 - 40 days, respectively.

11) Transplanting

Spacing of rice seedling is 25 x 25 cm and one hill consisted of 3 - 4 seedlings. As water management was not commonly practiced, rice transplanting is carried out under submerged conditions, and deep planting of rice seedling is accordingly observed.

12) Weeding

Hand weeding was extensively practiced. In the case of regular planting paddy, hand operating weeder was practiced in some limited areas. Weeding was used to carry out 4 and 8 weeks after rice transplanting. No evidence of herbicide application was observed.

13) Harvesting

Local differences in the rice harvesting method can be observed and corresponds to the harvesting equipment and threshing methods of each farmer. In the case of panicle cutting, harvested ears were half dried by solar radiation on the ground surface before threshing. In the case of high level cutting, harvested tops were dried as a mound in the exposing open air and solar radiation before threshing. In the case of low level cutting, harvested straws were placed on any surface for threshing without previous drying.

Farmers have seldom or never stored harvested paddy grains by themselves, while Koperasi Unit Desa (KUD) has constructed storage facilities for farmers.

E. Soil Conditions

With the execution of important national policies in the planning of land development including plans to increase rice production, agronomical soil investigation has become increasingly important. However, the tropical soil study is still in the process of progress, and from time to time changes in agronomical soil classification and nomenclature are made. Detailed agronomical soil investigation of the entire country has not yet been completed.

As far as Java island is concerned, there is a soil map with multi-color prints which differentiates 24 soil types. For the other areas a hand written colored soil map is available. Besides those maps a simplified soil map with twelve colors published in 1975 is a useful reference.

(a) Classification of paddy soils

The Indonesian paddy is roughly classified into six soil types. Characteristics, distribution and relation with rice production of those soils are as follows.

(1) Alluvial soils

Alluvial soils occupy about 43% of the paddy of Java, about 3,500,000 ha. They cover the lands along the northern coasts of western and central Java, the southern coast of central Java and the Brantas River valley in eastern Java. There is a vast stretch of alluvial soil along the eastern coast of Sumatra.

The alluvial soil is formed by relatively new sedimentation, and its physical and chemical properties change considerablely according to the basic components. Productivity of an area, therefore, has very substantial local changes. The pH of the soil in Java Island becomes higher as it moves from west to east, and as its substitution volume becomes larger, more crop production can be expected from the soil. The Brantas River valley which is surrounded by volcanic mountains is a high production area, but the valley of Solo River which is under the influence of the mother rock of the Tertiary Period and the paddies of alluvial soil in the low lands along the coast has a low yield.

(2) Latosol

Latosol is a soil made by weathering under high humidity tropical climate, and is rich in aluminium and iron. Its color is from red to bright brown. Latosol occupies about 32% of paddies of Java. It abounds especially in western Java. Its soil structure is good and water permeable. Although it has favorable physical conditions, even its nitrogen content is low. Because of the high content of iron in the soil, hydrogen sulfide formed in the paddy soil, for the latosol paddies that have hard iron or manganese aggregates in them, water drainage is poor and chemical reduction advances, which causes loss of iron with the result of low production. In such rice paddies, the rotation of rice crop and farm crop production is advantageous, because farming keeps the soil in the oxidizing condition and it contributes to development of roots and it in turn improves rice production.

(3) Regosol

Regosol is a soil that consists of volcanic ash and marl. It covers a large area in Java and Sumatra. It occupies 14% of the irrigated paddies in Java, and more than half of it lies in eastern Java. It contains more sands than other soils. When paddy water is drained, the soil does not become solid because of its porosity. During irrigation the soil has an appropriate viscosity, which gives good physical properties. The regosol which contains marl is said to be most fertile. The phosphoric acid absorption coefficient of regosol is lower than that of other soils.

Volcanic ash soil surrounded with the active volcanoes, Semeru, Merapi, Raung, etc. in Java becomes most fertile in the period from the initial to the medium period of weathering. The soil color is blackish gray. A disadvantage of this soil is that its low content of *humus* and nitrogen, but fertilization activates potential fertility and high productivity is realized.

(4) Grumusol

Grumusol presents black or dark gray color. It is distributed in Java from the central region to the east, and it occupies about 300,000 ha. This is a very viscous soil, containing substantial clay minerals in monmolironite series. Its expansion with water absorption is large, and when it is dry it is very hard and cracks penetrate deeply. Its pH is high and its humus content is high also. Its substitution volume is large and it contains much lime, but because of its high phosphoric acid absorption coefficient, phosphatic fertilizer is required. In general paddies of grumusol have low productivity due to various limiting factors, but there are grumusol paddies in flat lands which yield unhulled rice of 5 ton/ha, where the farm management is excellent.

(5) Andosol

The surface layer of andosol soil is dark brown, and the lower layer is brown or yellowish brown and rich in organic matters. Its distribution is in relatively high lands in the volcanic areas where it is cool and rainy. The andosol soil is relatively thick and its content of nutrition is low, but the soil is light and porous. It is also called a mountain soil.

It is distributed widely over all of the volcanic areas of Java and Sumatra.

(6) Mediteran

This soil has been subjected to violent weathering, and possesses a block construction which is heavy and viscous. It contains relatively a large proportion of silica, and its pH ranges in 6.0 - 7.5. Its distribution is in the areas of eastern South Sulawesi and eastern Java where severe dry seasons prevail.

(b) Soil distribution in each province

The soil distribution of each province which was the subject of the present investigation is shown as Fig. 15, 16, 17, 18, 19, 20, 21 and 22. The soil distribution of paddies in each area is described below.

(1) Java Island (West Java, Central Java and East Java)

Java Island is an eastern wing of the mountain range from the Alps and through Himalaya and Andaman Island. Its area is about 130,000 km^2. Limestone, marl, sandstone and shale are the main rocks at the base of the Tertiary Period mountains or hills and new volcanoes cover them. It is thought that volcanic activities started in the middle of the Tertiary Period and they became vigorous into the Quaternary Period. There are still many active volcanoes, and their mother rock is mainly andesite, but basalt is also found.

The soil of Java Island is in general rich in clay, and even latosol which has good physical properties contains more than 60% of kaolin clays. In the paddies in western Java, much red-brown latosol is found, and the soil in areas along the northern coast is alluvial. In central Java besides latosol, black grumusol is common, and in the areas along the southern and northern coasts the soil is alluvial. In eastern Java much regosol that is dark gray in color and fertile is found, as well as grumusol, but latosol is limited.

(2) Sumatra (Aceh, North Sumatra, South Sumatra, Lampung)

The soil of Sumatra along the eastern coasts is alluvial , and in the western coast the soil in which podosol is predominant is much found. In Aceh, alluvial soils cover the area along the southern and northern coasts. Litosol and regosol that are in the podosol series cover the mountainous area. Alluvial soils are also distributed in North Sumatra and litosol in latosol series and podosol series is much found in the mountains. In South Sumatra, there is a large stretch of alluvial soil that contains organic matters. In Lampung the eastern area is alluvial soil and the western area is occupied by litosol in latosol and podosol series.

(3) Other outer areas (South Kalimantan, South Sulawesi)
Alluvial soils are found in the eastern coast and western area of South Kalimantan, and litosol and regosol in podosol series cover the mountainous area. In the paddies in South Sulawesi grumusol is much found and in the east, mediteran is distributed.

F. Agro-socio-economic Conditions

Since 1969, through the three Economic Development Plans (REPELITA I - III) self-sufficiency in food has been consistently the most important policy in Indonesia. Further efforts and consideration have to be made to:

1. stabilize production against weather and other natural conditions including pest damage, and

2. organize adequate distribution system for smooth marketing of foodstuff and its production materials.

(a) Socio-economic background of agriculture
Contribution of the agricultural sector to the Gross Domestic Product (GDP) in Indonesia has tendency to decrease in recent years, but it is still the largest with 36.8% in 1975 and 31.4% in 1980 (Table 23). Importance of the agricultural sector to the country is shown in the number of people engaged in agriculture: 72% in 1961, 67% in 1971. This suggests that, although the number of people working for agriculture is decreasing, about 2/3 of the total labor force is still engaged in agriculture. According to the agricultural statistics of 1973 (Table 24), the number of families engaged in agriculture is 14,373,000 with a cultivated area of 14,168,000 ha (farming area per family is thus 0.99 ha). Farm agriculture families are concentrated mainly in the Java Island and there farming area per family is only 0.6 ha.

(b) Population and production of rice

Table 25 shows the results of a comparison of the statistics of 1971 and 1980. In those 10 years the annual rate of population increase was as high as 2.32%. On the other hand, the increase in rice production is as follows:

1. 10 years from 1971 to 1980: 46.9% (annual average 4.69%)
2. 5 years from 1971 to 1975: 10.7% (annual average 2.14%)
3. 5 years from 1976 to 1980: 27.3% (annual average 5.46%)

This comparison shows that rice production intensification programme has provided positive results in recent years.

(c) Rice Production Intensification Programme

Since 1965 BIMAS Programme has been positively promoted. There are five principles in this Programme:

1. introduction of high yielding rice varieties,
2. application of fertilizer,
3. pest control,
4. improved cultural practices, and
5. adequate and timely irrigation.

For the realization of those targets, the government offered credit and production facilities at cost which is supported by the government subsidy, thereby expecting increase in the rice production and farmers income.

In the above targets it is reported that the yield loss due to disease and pest will be about 20 percent. If appropriate control measures are taken, 17 -20% increase in production will be expected (Lembaga Pusat Penelitian Pertanian; Bogor 1977, Aspek Pestisida di Indonesia).

(d) Agricultural environment in Java Island

As shown in Table 26, about 62% of the total population live in Java and Madura islands which occupies only 7% of the total area. As shown in Table 27, 63% of the rice, more than 70% of corn, cassava, peanut and soybean are produced in Java Island. As for the scale of farming, farming land holding per one family of more than 60% of the farming families does not reach 0.5 ha as shown in Table 28. Particularly in Java Island land utilization intensity is very high, leaving almost no area for possible further land development for farming. Accordingly, to increase production of rice in the area development of irrigation, introduction and extensive use of the high yielding variety and adequate control of disease and pest should be strongly promoted in close collaboration with agricultural research institutes.

(e) Agricultural environment in outer Java Islands

1) Sumatra

Sumatra occupies 25% of the whole area of Indonesia, but its population makes up only 19% (population density is 59/km^2) of the total of Indonesia. Its rice field area is less than that of Java Island, but estate area is about two times greater (Table 24). The area of rice field of Aceh, South Sumatra and West Sumatra occupies 59% of the total of Sumatra and the area of upland rice of South Sumatra, Bengkulu, Lampung is 56% of the whole Sumatra (Table 29).

In the province of Aceh, rice farming is stable and it is self-sufficient in rice production with a surplus.

In South Sumatra and Lampung provinces, farming areas are not so big comparing its vast land area, and upland rice fields of these provinces are respectively 31% and 45% of the whole rice fields, therefore the production of rice per ha is small. The southern provinces of Sumatra are nearer to Java Island and immigrants from Java live there. Those provinces have a high increase in population, with Lampung Province averaging 6% (Table 25) per annum in last 10 years.

2) Kalimantan

Kalimantan Province occupies 28% of the whole area of the country, but its population is only 4% (population density is 12/km^2). Much of the area is still potential land for agricultural development. Most of the area is covered by forests.

In South Kalimantan Province, rice is cultivated along the Barito River on the right side basin . In the area near the sea where tidal water has influence on the rice field, floating rice is cultivated and in the area where river flows, LEBAK rice cultivation is carried out. Cultivation in these areas depends on rainfall, with irrigated area of less than 5%. Accordingly those areas are liable to suffer from flood or drought.

3) Sulawesi

Density of population in Sulawesi is about the same as that in Sumatra Island. As a whole this province is favored in irrigation water with fertile soil. Historically it has high agricultural productivity. About 60% of the whole population live in the South Sulawesi province, and they produce 73% of the rice crop of the whole Sulawesi Island.

There are still many undeveloped areas left for paddy cultivation, and since they have favorable conditions of soil and irrigation, this province has a large potential for increase of food production.

(f) Present rice crop management system

1) Key farmer system

The Key Farmers are those who are farmers and influential in an area or possess a large area of cultivated land (in the outer area, 2 - 3 ha, and in Java 1 - 1.5 ha) and who are selected by the Agriculture Extension Worker (PPL). One Key Farmer (Kontak Tani) is assigned to 10 Progress Farmers, and one Progress Farmer is assigned to 10 Family Farmers. In short one Key Farmer becomes the leader of 100 Family Farmers. Those 100 Family Farmers are one unit, and are considered as the farmer group (Kelompok Tani). The scale of organizing those cooperative bodies changes according to the area. The cooperative control of disease and pest is under the guidance of Agricultural Extension Service and Crop Protection Brigade, and it is conducted by groups of farmers.

2) Agriculture extension system

The administrative units of the rice crop protection system by the government are Province, Kabupaten, Kecamatan and Desa. An organizational integration of some Kabupatens, Kecamatans or Desas is called Karesidenan, Kawedanan or Kemukiman, and they are also used in some areas. In addition to them, there are Wilaya

Unit Desa (WUD), Badan Usaha Unit Desa (BUUD) in the BIMAS programme, and Koperasi Unit Desa (KUD) which was organized by the cooperative association policy are run by the credit of the Indonesia People's Bank (BRI).

The Rural Extension Center (BPP) are set up on the level corresponding to Kecamatan which is involved in two to five BUUD and KUD. One Agriculture Extension Worker (PPL) who belongs to this office is assigned to 600 -1000 ha farm area. The area to which the Agriculture Extension Workers is responsible varies considerably, because the cultivated area per one family is 0.25 ha in east Java and 0.8 ha in South Sulawesi. To the office two senior Agriculture Extension Workers (Programmer and Supervisor) and one Observer Worker are assigned. They receive instructions, information and reports from the Agriuculture Extension Service who are attached to the Provincial Food Crop Agriculture Service (Dinas Pertanian Tanaman Pangan).

In the BIMAS Programme, seeds, fertilizer and agricultural chemicals are given credit. The interest for this service is 1% per year; repayment is being collected without difficulty. In the INMAS Programme farmers receive agricultural guidance by their own funds and they receive resources from the government. Seeds come from the Seed Center which is set up in every province and also from the farmers to whom seed production is trusted. Price of seeds depends on the area and is in the range of 175 - 250 Rp/kg. In West Java seeds from the government have red label and those from a private farmer have blue label. Urea, TSP and KCl are all the same price, namely 70 Rp/kg. In the BIMAS Programme they are delivered to the farmers' houses, but in the INMAS Programme they are sent up to KUD. Pesticides are sold at an unified price, 1,250 Rp per 1 liter or 1 kg of liquid, while granule sold at 350 Rp per 1kg. If some farmers run short on their supply, these chemicals are sometimes sold for 2,000 Rp.

There are two channels for the flow of production goods. One is from the Agriculture Production Goods Company (P.T.Pertani Lini I -III) through the Central Village Cooperative Unit (PUS KUD), KUD, KUD Kios and the other is from a private company through stores that are usually run privately. For rice crops most of the production materials go through Lini and KUD, and those through private stores are for plantation and other crops. Payment is made through BRI.

3) Agriculture information center

For the extension of agricultural technology, research, education, agriculture extension, etc. to fully function, the government has tried to organize those activities. The budget to run the present Agriculture Information Center was set up in 1979, and the first year budget was 14,000,000 Rp, while in 1982 it became 150,000,000 Rp. The headquarters is in Ciawi and local centers are set up in Gedong Johor, Padang, Tegineneng, Kayuambon, Ungaran, Wonocolo, Mataram, Bunjarbaru and Ujung Pandang, and in 1982 new centers will be constructed in Aceh and Ambon. They are now publishing pamphlets on agriculture and hand books for the agriculture extension personnel and a magazine, 'Bulletin Informasi Pertanian' by their information and news collecting activities.

4) Crop insurance policy

Regarding the rice crop, there is no insurance policy in Indonesia. Public Food Corporation purchases unhulled rice after the harvest by a government supported price. Accordingly, from the point of harvest the farmers are insured of a good sales price, but if there occurs a flood, drought or damage due to disease or harmful insects during the growth time of rice, the farmer is greatly affected. An insurance policy to safeguard the farmers against those damages should be considered.

G. Rice Crop Protection System

(a) Organization

1) Organization structure of central government

The organization chart of the central government concerned with forecasting and control of disease and pest for food crop in Indonesia is shown in Fig. 23 and 24. Directorate of Food Crop Protection in Pasarminggu belongs to Directorates General of Food Crop Agriculture of the Ministry of Agriculture which supervises four Sub-

Directorates-Sub-Directorate of Pest Observation and Forecasting, Sub-Directorate of Field Pest Control, Sub-Directorate of Pesticides and Sub-Directorate of Vertebrate and Storage Pest.

On the other hand at the provincial level, there is the Food Crop Protection Center which instituted and supervises Forecasting Laboratory which corresponds to the several Kabupaten which have similar agroecosystem and also Pest Observatory Unit which corresponds to the level of Rural Extension Center Area (WKBPP) is organized. There is a plan to set up three Pesticide Laboratories which is under the jurisdiction of Sub-Directorate of Pesticides at Medan, Ujung Pandang and Surabaya.

2) Organization structure of provincial government organs

Fig. 25 shows the organization structure of each provincial government. Each provincial government maintaines an Agricultural Service which includes a Crop Protection Section. The Crop Protection Section is set up in the office of Kabupaten, and it supervises the Agricultural Extension Office that is set up at the level of the Kecamatan.

(b) Function

The four Sub-Directorates of Directorate of Food Crop Protection at Pasarminggu conduct overall policies for the country regarding forecasting of disease and pest occurrence for food crop, protection and registration of pesticides and their quality control and safe use, and also make plans for each fiscal year.

The Food Crop Protection Center set up by each province executes works that are run by province in the same way as Directorate of Food Crop Protection. The Forecasting Laboratory which is on the same level as Karesidenan is the most active place, where the facilities, equipment and engineers are assigned for obtaining information about occurrence of disease and pest and damages in the whole area, and Pest Observers stationed at Pest Observatory Unit carry out field observation on the occurrence of disease and pest every week.

On the other hand, various works regarding pesticides, their registration, quality control and their safe use have been carried out by the Sub-

Directorate of Pesticides at Pasarminggu only, but because substantial agricultural chemicals are used in Indonesia, dispersion of its works to branch offices to raise efficiency is planned.

The works of Province Agricultural Service have been concentrated on agricultural extension works, and a senior extension worker is assigned to Province Agricultural Service and the office of Kabupatan. In Rural Extension Center, the senior Agriculture Extension Workers there provide supervision to the Agriculture Extension Workers who participates in the most key part of actual agriculture extension work. They are in contact with 16 Key Farmers who are the leaders of Farmers Groups, and each Key Farmer is in contact with the 10 Progress Farmers under him. Each Progress Farmer works in cooperation with 10 Family Farmers in each organization. Necessary information disseminates to Farmers Groups promptly and smoothly.

(c) Observation of diseases and pests and dissemination of information

The Observer Worker divides his responsible area into four sections by a specified procedure, and he selects at random 4 rice paddies from one section which under the same conditions of rice varieties cultivated, growing stage of rice, and for each rice paddy he picks up three 1 m^2 areas on the diagonal line of the paddy, and in each 1 m^2 area every plant is checked for damage by disease or pest or both. On the other diagonal line he sweeps an insect net to catch and investigate harmful insects. His investigation covers four rice paddies of the said section in one day, so takes four days for his responsible area. Next day he prepares a report on his findings to present regional meeting to be held on the following day or to be reported to the Kabupaten level and Rural Extension Center (BPP). At present one Observer Worker covers 6,000 -10,000 ha, which is too large for him to carry out his work and obtain data with satisfactory thoroughness.

The data thus obtained by the Observer Workers are disseminated to Agricultural Service of Provincial Office through Rural Extension Center and also to the Derectorate of Food Crop Protection through the Forecasting Laboratory. However, the impression is that the channels to convey information has not been established for the outbreak of a disease or pest.

On the other hand, agricultural information is communicated along the organization structure of agriculture extension in Provincial Agricultural Service.

(d) Disease and pest control

A five-man team, Crop Protection Brigade as a unit, is organized for control of disease and pest. A team includes one leader, two workers for protection, one maintenance engineer and one driver. Each team has an office, a machinery warehouse, pesticide storage and garage. The Brigade belongs to Food Crop Protection Center. Their offices sometimes are in the branch offices in DINAS or Rural Extension Center, or independent. It seems that those teams are working in the administrative organization of Provincial Agricultural Service. When damage to more than 100 ha is foreseen, teams go out on request with the chemicals spraying equipment and are guided to infested areas by the farmers. More than 50 sprayers are kept by one team. Spraying equipment is out of service by 50% in two years and by about 70% in three years. Replacement parts are not available and because there are so many manufactures with few interchangeable parts, it is almost impossible to repair a machine that is out of order.

(e) Training and education of officials

In the case of the Observer Workers, if one of them is employed, he receives orientation in Agricultural Service for about one month, and later he is assigned to actual field work. During this period he repeatedly receives the education at Training Center and learns up-to-date methodology on field investigation. The training and education consists of general survey of disease and pest in two days and in field training in one day at most of the centers.

(f) Registration and quality control and safe use of pesticides

Sub-Directorate of Pesticides is responsible to the whole controlling administration for all pesticides, and makes instructions regarding control of pesticides, their registration and their safe use, including a test of chemicals.

1) Control and test of agricultural chemicals

Sub-Directorate of Pesticides places emphasis on the quality test according to the following regulations: sales, storage and use of agricultural chemicals (as of March 1973), packing and indication of agricultural chemicals (as of September 1973), registration and approval of agricultural chemicals (as of November 1975). As for poisonous chemicals, restrictions are laid on the total amount and use of active ingredients and their sales, while for formulation, chemical analysis and physical property measurements are carried out.

Test specimens are taken at random from the registered chemicals and chemicals in the market. The test methods are based on the CIPAC Handbook and the amount of active ingredient, color, pH, stability in emulsion, density, viscosity, moisture and suspendability are tested.

Residual chemicals in rice, cabbage, sawi (a type of vegetable), potato, carrot, tomato and the irrigation water are measured.

The number of formulation analyses is 20 cases per month, but the capacity is up to 50 cases. The measurement of physical properties is at the rate of one case per day.

2) Treatment of waste pesticides

The waste pesticides are stored in a vessel for a while, then they are subjected to alkali decomposition at a suitable time and later drained with large quantities of water. Of chemicals with which the test is finished those that are satisfactory are given to farmers, and the other is stored in a 20 - 25 litre tank. If an incinerator is installed, it will be incinerated.

3) Training of personnel

One personnel each is sent to Japan and East Germany for two months and one month respectively. The training in Japan is concerned with the analysis of active ingredients, measurement of physical properties and analytical technique for residual agricultural chemicals, and visitation of related works. The training in East Germany aims at distilling technologies of chemicals production.

4) Record of work

The following gives the results of the work executed in Sub-Directorate of Pesticides during 1980 - 1981.

Analyses of active ingredients in chemicals: 128 cases (pesticides 118 cases, bactericides and fungicides 4 cases, rodenticides 4 cases and others 2 cases), and by ingredients, organic phosphoric agents, 76 cases, organic chlorides, 10 cases, carbamate agents, 29 cases, pyrethlloyd agent 3 cases.

Analyses of residual chemicals: 56 cases (cabbage 13, sawi 7, potato 7, carrot 3, tomato 10, rice 14, irrigation water 2), and by ingredient, organic phosphoric agents 30, organic chlorides 26.

5) Future plan

Future plans call for expansion of the laboratory and strengthening facilities at Pasarminggu, taking into consideration the present facilities, work space and work load, and additionally construction of three branch laboratories at Madan, Ujung Pandang and Surabaya for local quality control.

(g) Cooperation with agricultural research institution.

There are very few students who major in the field of agricultural disease and pest at universities, agricultural colleges, agricultural junior colleges and agricultural high schools. For instance, at the University of Lamburng Maugkurat at Bunjarbaru which was founded 20 years ago only 55 students graduated in 20 years from the agriculture faculty and those who majored in crop protection are only 15, which means that the average per year is less than one graduate. In view of this situation it seems that the officials who received education at the Bogor Agriculture University (Bogor) and Gadjah Mada University (Yogyakarta) are carrying out the task to give guidance in the field of food crop protection.

Establishment of methodologies in monitoring the occurrence of disease and pest, their investigation in the field and evaluation of the damage is the function of research organs, but there can be found almost no plans for cooperation in technologies that are organized and scheduled in this discipline. Where voluntary cooperative organizations among the directors of Food Crop Protection Center and Provincial Governor, officials in charge of Agriculture Service and directors of research laboratories of the university is set up, countermeasure conference is summoned when a problem breaks out and opinions are exchanged therein. The study team was unable to note a case of actual adoption of the results of the conference in the present study aimed at forecasing and control of disease and pest.

VI. Master Plan

Based on the results of this study on the organization and functions for the plan to strengthen forecasting and control of disease and pest for rice and taking into consideration effective execution of the national programme for food crop protection that will be enlarged and advanced, a Master Plan is hereinafter presented.

The work space necessary for carrying out the Project which involves administration and technology is to be established in the capital by rationalization of the facilities of Directorate of Food Crop Protection and will aim at smooth execution of the works all over the country. For carrying out projects that are locally required, Food Crop Protection Centers will be set up at 7 locations and Forecasting Laboratories at 20 locations and Pest Observatory Units at 100 locations, and Pesticide Laboratory at three locations for quality control of agricultural chemicals and their safe use, and they will be equipped with necessary facilities and equipment. On the other hand in order to raise capabilities and technique of officials of those institutions a plan for education and training was formulated.

The construction of the buildings, facilities and installation of equipment and training are planned as a five year plan and the budget for carrying out the Project is US$ 48 million. If execution of the plan gives results as envisioned, not only prevention of the damage caused to the crop directly by crop disease and pest, but also rice crop of high quality is expected, and the original target of self-sufficiency becomes one step closer, and the technologies established through carrying out the 5-year plan for forecasting and control of disease and pest can be applied to the production of other various agriculture crops, and effective utilization of production materials will bring forth saving in the production cost.

A. Buildings and Facilities

Centralized advancement of the Project for forecasting and control of food crop disease and pest is only feasible when the Project is executed locally by taking into consideration region related characteristics on pest conditions. The effects of administrative activities depend, therefore, on the availability of information regarding the methodologies of forecasting and control of desease and pest. In planning buildings and facilities, each technical department or section is provided with a laboratory, so that officials who belong to it can become familiar with the actual situation in which disease or pest out breaks occur and obtain and accumulate fresh knowledge about problematic points in forecasting and control of disease and pest and techniques to solve them, and thereby they can be encouraged to learn and obtain more experience. From this standpoint the building coverage, personnel and water to be used by Directorate of Food Crop Protection, Food Crop Protection Center, Forecasting Laboratory, Observatory Unit and Pesticide Laboratory are summarized in Table 30.

(a) Food Crop Protection Center (Fig. 26, 27, 28, 29, 30, 31 and 32)

Table 1 shows the location where Food Crop Protection Center will be established and its area of responsibility, since it is considered more functional to increase the number of Forecasting Laboratories where the execution of the work with the help of Observatory Unit can be carried out instead of increasing the number of Food Crop Protection Centers.

As shown in the figures, there is provided Chief's room (40 m^2), office (70 m^2), specialist's room (70 m^2), staff room 70m^2, laboratory (210m^2), meeting room (214.5 m^2), library (72 m^2), Crop Protection Brigade (spray equipment warehouse, pesticide storage, office, etc.) (140 m^2) and warehouse, water supply station, incinerator station, generator station and staff house.

(b) Forecasting Laboratory (Fig. 33, 34, 35 and 36)

As shown in the figures, the building will be provided with the following rooms: Chief's room (40 m^2), office (98 m^2), meeting room (98 m^2), laboratory (180 m^2) and others (staff house, storage, water supply station, incinerator station, generator station, etc.).

(c) Observatory Unit (Fig. 37)

As shown in the figures, the office (27 m^2), project room (51 m^2) and others including staff house and storage are provided.

(d) Pesticide Laboratory (Fig. 38, 39, 40 and 41)

As shown in the figures the building will be occupied by Director's room (40 m^2), office (48 m^2), meeting room (60 m^2) staff room (96 m^2), laboratory (144 m^2), and other samples room, storage, incinerator station, generator station, water supply station and staff house.

(e) Location and number of buildings proposed

Food Crop Protection Center:	Medan, Palembang, Bandung, Semarang, Surabaya, Bajarmasin, Ujung Pundang (7 locations in total)
Forecasting Laboratory:	West Java, Central Java, East Java, (3 laboratories at each), Aceh, North Sumatra, South Sumatra, South Kalimantan, South Sulawesi (2 laboratories at each), Lampung (one laboratory); (20 laboratories in total)
Pest Observatory Unit:	West Java, Central Java, East Java (15 units at each), Aceh, North Sumatra, South Sumatra, South Kalimantan, South Sulawesi (10 units at each), Lampung (5 units); (100 units in total)
Pesticide Laboratory:	Medan, Surabaya, Ujung Pundang (3 laboratories in total)

B. Equipment

The vehicles and equipments that are expected to be required and used for smooth execution of the Project of forecasting and control of rice disease and pest are summarized in Table 31 and listed in detail below:

(a) Directorate of Food Crop Protection

Telecopier	1
Jeep	3
Personal computer	1
Laboratory waste incinerator	1
Toxic gas incinerator	1
Copying machine	1
Electric precision balance	3
Universal biological microscope	2
Binocular stereo-microscope	4
Biological binocular microscope	2
Microscope lighting apparatus	6
Video set	1
Camera	2
Slide projector	2

Daylight screen	2
Reflect microscope	1
Grain moisture meter	1
Electrophoresis apparatus	1
Micro syringe	5
Constant temperature inoculator	1
Ripening rate measuring apparatus	2
Miniature thresher	2
Fish toxicity test chamber	1
Momentum measuring apparatus	1
Auto sterilizer	1
Rice yield analyzer	1
Solvents	1 set
Chemical reagents	1 set
Glass wares	1 set
Grinder	2
Mass-rearing cabinet	20
Seedling case set	10
Desiccator	20
Laboratory dish (shale)	100
Sample jar	1000
Killing jar	10
Tweezer	10
Hurricane lamp	10
Insect net	20
Insect sweeping net set	5
Magnifier lense	5
Hand numbering apparatus	5
Electronic calculator	10
Experimental supply	1
Insect specimen cabinet (30 specimen boxies)	20
Portable insect specimen box	10

Sub-Directorate of Pesticides

Top loading balance (capacity 5 kg)	1
Analytical electric precision balance	3
Ultra-violet light detection lamp	2
High purity auto-still	1

Recording data processor (gastorgraphy and liquid chromatograph)	3
High performance Liquid chromatography set	1
Liquid chromatograph packed column set	1
Shaker set	1
Gas-cylinder carrier	1
Ultrasonic pipette washer	2
Oscilloscope	1
Burner for glass working	1
Compressor for glass working	1
Glass cutter set	1
Physical properties measuring apparatus (flash point, accelerated storage, bulk/tap dencity flowability, particle size, dispersibility, hardness, moisture content)	1
Standard sieve set	1
Electric sieve set	1
Auto cube-ice machine	1
Ultrasonic cleaner	1
Automatic mortor	1
High-speed automatic cutter	1
Gas-cylinder rack	5
Gas chromatography set	1
Gas chromatograph packed column set	1
Hydrogen leak detector	1
Constant temperature oven	1
Experimental supply	1

(b) Food Crop Protection Center

Telecopier	1
Jeep	3
Pick-up jeep	1
Motorcycle	10
Laboratory waste incinerator	1
Toxic gas incinerator	1
Air conditioner	4
Universal biological microscope	2
Binocular stereo microscope	4
Biological binocular microscope	2
Microscope lighting apparatus	6
Camera	1

Slide projector	1
Daylight screen	1
Micro syringe	2
Ripening rate measuring apparatus	1
Miniature thresher	1
Seedling case set	10
Constant temperature inoculator	1
Rice yield analyzer	1
Mass-rearing cabinet	10
Constant temperature oven	1
Desiccator	10
Laboratory dish (shale)	100
Sample jar	500
Killing jar	10
Tweezer	10
Hurricane lamp	50
Insect net	100
Insect sweeping net set	30
Magnifier lense	50
Hand numbering apparatus	50
Electronic calculator	10
Mist blower	100
Experimental supply	1
Insect specimen cabinet (30 specimen boxes)	5
Portable insect specimen box	5

(c) Forecasting Laboratory

Telecopier	1
Jeep	1
Motorcycle	10
Air conditioner	4
Instrument shelter	1
Thermograph	1
Hydrograph	1
Recording wind vane and anemograph	1
Rain gauge	1
Solarimeter	1
Binocular stereo zoom microscope	2
Biological binocular microscope	2

Binocular stereo-microscope	2
Camera	1
Rotary spore-trap	2
Light trap	2
Micro syringe	2
Constant temperature inoculator	1
Ripening rate measuring apparatus	1
Miniature thresher	1
Seedling case set	10
Constant temperature oven	1
Mass-rearing cabinet	10
Desiccator	10
Laboratory dish (Shale)	100
Sample jar	200
Killing jar	10
Tweezer	10
Hurricane lamp	30
Insect net	50
Insect sweeping net set	10
Magnifier lense	10
Hand numbering apparatus	10
Electronic calculator	4
Mist-blower	5
Experimental supply	1
Insect specimen cabinet (30 specimen boxes)	2
Portable insect specimen box	5

(d) Observatory Unit

Motorcycle	1
Binocular stereo-microscope	1
Laboratory dish (Shale)	50
Sample jar	100
Killing jar	5
Tweezer	5
Hurricane lamp	10
Insect net	20
Insect sweeping net set	5
Magnifier lense	5
Hand numbering apparatus	5

Electronic calculator	2
Mist-blower	2
Insect specimen cabinet (30 specimen boxes)	1
Portable insect specimen box	5

(e) Pesticide laboratory

Laboratory waste incinerator	1
Toxic gas incinerator	1
Gas chromatography set	1
Gas chromatograph packed column	1
High performance liquid chromatography set	1
Liquid chromatograph packed column	1
Recording spectro-photometer	1
Thin layer chromatography set	1
Electrophoresis apparatus	1
Automatic potential difference titrator	2
Thermometer set	1
Viscosity meter	1
pH meter	1
Hydrometer set	1
Standard sieve set	1
Electric sieve set	1
Electric precision balance	2
Analytical electric precision balance	2
Constant temperature oven	2
High purity auto-still	1
Ultrasonic pipette washer	1
Water bath	2
Mantle heater	2
Hot plate	2
Vacuum dryer	1
Vacuum pump	1
Oven dryer	3
Incubator	1
Centrifuge set	2
Refrigerator	4
Deep freezer	1
Auto cube-ice machine	1
Shaker	2

Rotary vacuum evaporator	2
Muffle furnace	1
Laboratory stirrer	1
Mug mixer	2
Touch mixer	1
Handy aspirator	1
Juicer-mixer	3
High-speed automatic cutter	1
Soxhlet extractor	10
Concentration apparatus (for Soxhlet)	5
Distillering apparatus	1
Glass wares	1
Stop watch	2
Laboratory timer	2
Laboratory clock	4
Experimental supplies	1
Tester	1
Tool kit	1
Safety mask	50
Safety glasses	10
Safety gloves	10
Fire extinguisher	15
Hydrogen leak detector	1
Eye washer	1
Ventilation fan	20
Draft chamber	3
Laboratory cart	2
Voltage stabilizer	4
Air conditioner	10
Cooking set	1
Solvents	1 set
Chemical reagents	1 set
Inter-phone	12
Telephone	1
Camera	1
Electronic calculator	10
Copying machine	1
Typewriter	1
Jeep	1
Motorcycle	4

C. Organization and Function

The important point in the proposed organization structure and functions for forecasting and control that are different from those in the present structures are: (i) the central and local institutions will have their own experiment programmes and execute tests thereby under taking immediate necessary technical measures, (ii) the headquater of the Crop Protection Brigade is located within Food Crop Protection Center, and by this an overall pest control scheme can be monitored with smooth operation of peripheral control activities.

(a) Organization chart

The organization, structure and administrative system regarding forecasting and control of disease and pest in the central government structures and provincial government structures are the same as the present which is shown in Fig. 23, 24 and 25.

(b) Function

Experimental function on pest forecasting and control methodology-pest surveillance and monitoring, assessment of damage, economic and effective pest control, pest forecasting formula, etc. - is incorporated. Therefore, the functions expected from each institution by those who are concerned are a little different from the existing system. The work assigned to each institution is as follows.

1) Directorate of Food Crop Protection

- making project achievement plan for each fiscal year at the national level
- adjusting nationwide project plans and management of food crop protection scheme of provinces
- planning budgetary appropriation and allocation
- planning manning schedule
- collecting, preparing and disseminating forecasting and control information at the national level
- completing experimental works on pest forecasting and control problems at the national level
- planning training programme
- Evaluation, guidance and supervision

2) Food Crop Protection Center

- preparing project achievement plan for each fiscal year at the regional level
- planning budgetary appropriation and allocation at the regional level
- supervising forecasting and control scheme of Forecasting Laboratories
- planning manning schedule at the regional level
- collecting and analyzing information and data on pest forecasting and control at the regional level
- preparing and disseminating pest forecasting and control information at the regional level
- completing experimental works on pest forecasting and control problems at the regional level
- collecting and processing meteorological data
- monitoring disease and pest outbreak in the region
- planning and executing training programme
- guiding pest control technology and giving pest control materials to the Crop Protection Brigade

3) Crop Protection Brigade

- examining disease and pest outbreaks for preparing control measure
- conducting disease and pest control together with farmers group
- to maintain pest control equipment

4) Observatory Unit

- conducting observation on disease and pest outbreak required for preparing manual
- preparing and disseminating information on pest forecasting and control at the Desa level

5) Sub-Directorate of Pesticides (Pasarminggu)

- running registration of pesticides
- evaluating pesticide efficacy and safety
- supervising distribution, storage and application of pesticides
- preparing pesticide legislation plan
- distributing information on safe and effective use of pesticides

6) Pesticide Laboratory

- running analysis on quality control of pesticide formulation at the regional level
- monitoring safe use of pesticide/pesticide residue by collecting and running analysis on food crop and environmental samples

D. Cooperation with Agricultural Research Institutions

The practical methodology on pest forecasting and control has to cope with the dynamic change of disease and pest population which depends closely on changes of the environment. Therefore, continuous basic observation and study on pest occurrence is required. At present, however, it is difficult to collaborate with agricultural research institutes in carrying out cooperative research programmes. It is recommended, therefore, to have a comprehensive conference regarding pest forecasting and control in the wet and dry seasons, which draws attention to agricultural researchers and engineers for obtaining the latest information and advice of methodology on pest forecasting and control.

It is also recommended to collect the latest technological information from transactions, magazines and proceedings of international conferences of academic agricultural associations, and to test some related technologies from them at suitable experimental facilities of Directorate of Food Crop Protection, Food Crop Protection Center or Forecasting Laboratory, and to modify / create applicable measures to the crops of Indonesia.

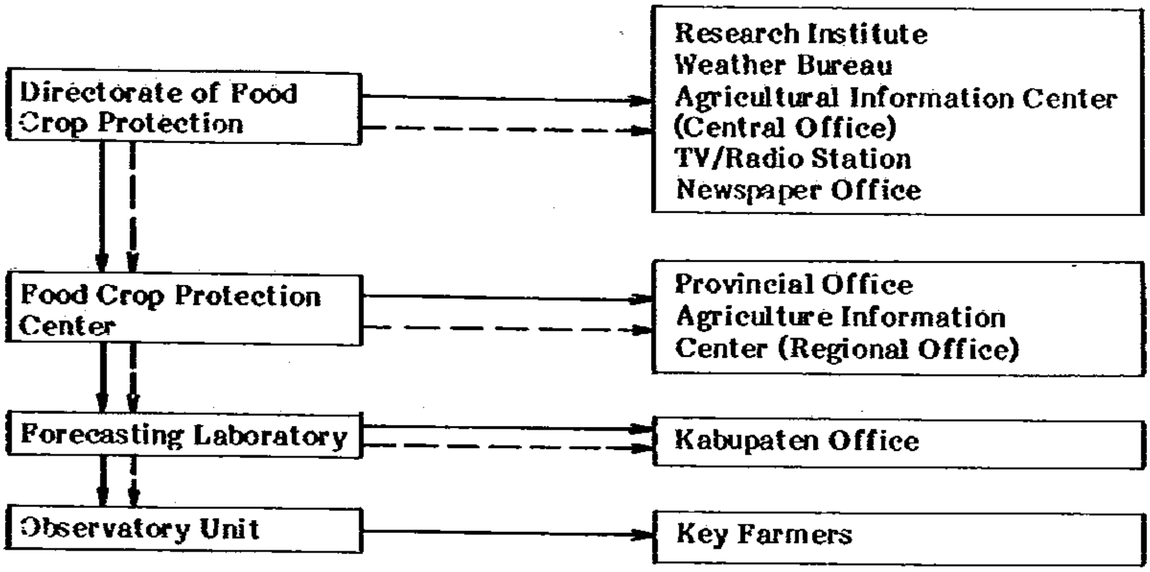
E. Dissemination of Information

Dissemination of the information made for pest forecasting and control and/or pest outbreak must be exact and fast. The following dissemination system is proposed, taking into consideration the existing telegraph / telephone communication system of Indonesia.

- Motorcycle or jeep is provided for communication of Pest Observatory Unit-Forecasting Laboratory, Pest Observatory Unit-Farmers Group, Pest Observatory Unit-Agricultural Service at the Desa level.
- Telecopier is provided for communication among Forecasting Laboratory Food Crop Protection Center and Directorate of Food Crop Protection.

- Basic information that is programmed for computer and micro-computer with the justification of the information is facsimiled to Food Crop Protection Center.

Information on pest forecasting and control based on field observation reported or transfered as shown in the simulation diagram hereunder.



Collected information is arranged and analysed, and information on pest fore-casting and control thus made is disseminated according to the diagram above.

The information about outbreak of disease and/or pest and information regard-ing warning and emergency control is distributed with priority to the area where it occurs.

F. Training

It seems urgently needed that the officials working for forecasting and control learn the latest technologies, and the officials who have received study and training for this need will be, after returning to their job, the source of modifying and creating technologies to meet local conditions based on what they have studied and learned.

Training is given to the officials who engaged in forecasting and control schemes according to the programs prepared by the type of work, so they can be expected, after they have finished the training, to contribute to improved work and raised technology, and to make rapid investigation and to prepare information and also distribute instructions to farmers promptly.

At least once a year a nationwide training programme is conducted for the officials of Food Crop Protection Center and Provincial Office with Directorate of Food Crop Protection as organizer.

Other training at the regional level is proposed to be organize at least twice a year with emphasis on technical study and trainng for officials of Forecasting Laboratory, Observatory Unit, Crop Protection Brigade and Agriculture Extension Offices. The organizer is Food Crop Protection Center.

The training organized by Food Crop Protection Center at the Desa level is targeted for control of disease and pest that effect crops during the wet and dry seasons. The training is for those local farmers and conducted by a program that takes into consideration the characteristics of local conditions.

The place to hold regional training is, if possible, selected where a problem in forecasting and control has been experienced, and those who lead the programme, should be able to ensure that the problems of the field are the subjects of the study and training and are related to actual means to overcome the same.

G. Implementation Schedule

Assuming that the proposed Project is to be supported by an international loan aid programme, the implementation schedule will be as set forth in Fig. 42 and is summarized as follows.

1. The first phase will be devoted to the basic design, detailed design, procurement and tender for approximately 2 years. Highly qualified experts will be engaged for consulting service including such expertise as crop protection, construction design, structural engineering, facility engineering and contract administration.

2. The second phase will be for actual construction and installation of equipment for approximately 3 years. Training component will also be implemented during this period. Highly qualified experts will be required

for consulting service including such expertise as crop protection, construction design, structural engineering, facility engineering and electric engineering.

As stated above, after a preparatory period of about 2 years for basic design, detailed design, procurement and tender, actual construction and installation will start in the begining of 3rd year and be completed by the end of 5th year after commencement of the Project. It is essential to provide the service of experienced engineering consultants to assist the Government in the effective implementation of the Project. Terms of Reference for such consulting service are summarized below:

1. Project Planning and Scheduling
   - Planning, scheduling, coordinating and monitoring all activities including tender document, contract works and work undertaken by the Government

2. Contract Administration and Construction Supervision
   - Preparation of tender documents
   - Tender evaluation and recommendation of award of contract
   - Review of activities of contractor work in the field
   - Checking quality and acceptability of work in progress

3. Procurement of Equipment and Vehicles
   - Preparation of tender documents for procurement of equipment and vehicles
   - Evaluation of tender and recommendation of award of contract
   - Supervision of installation of equipment

4. Training Programme and Manual Preparation
   - Preparation of overall Training Programme
   - Preparation of manuals for rice pest forecasting and control activities

H. Cost Estimate

Project costs for the construction of the buildings and facilities and procurement of equipment are estimated on the assumption that the procurement will complete according to the implementation schedule.

Purchase costs for equipment parts are estimated as 40% value of the total category. Though the disbursement of these costs would normally be in four to five years after initial investment, advance disbursement is recommended within the term of the Project in view of their essential role in the timely progress of works.

Operation and maintenance costs include salary, travelling expenses of officials and operation expenses of facilities. Annual total costs are roughly estimated with break-down to Crop Protection Center - US$ 212,000, Forecasting Laboratory - US$ 25,000, Pest Observatory Unit - US$ 4,000 and Pesticide Laboratory - US$ 100,000.

Physical contingency costs are estimated as 15% of the total costs.

No allowance was made on Cost Escalation in commodities.

Costs thus estimated amount to ¥12,089 million (US$ 48 million) in total as shown in the following table.

(Unit: '000 Yen)

Description	First Year	Second Year	Third Year	Fourth Year	Fifth Year	Total
Building & Facilities						
Food Crop Protection Center			861,630	574,420	574,420	2,010,470
Forecasting Laboratory			1,153,845	769,230	641,025	2,564,100
Observatory Unit			732,420	488,280	406,900	1,627,600
Pesticide Laboratory			150,798	150,798	150,798	452,394
			(2,898,693)	(1,982,728)	(1,773,143)	(6,654,564)
Equipment						
Dir. of Food Crop Protection			92,719	0	0	92,719
Crop Protection Center			80,307	53,538	53,538	187,383
Forecasting Laboratory			109,125	72,750	60,625	242,500
Observatory Unit			32,985	21,990	18,325	73,300
Pesticide Laboratory			57,657	57,657	57,657	172,971
			(372,793)	(205,935)	(190,145)	(768,873)
Spare Parts						
Dir. of Food Crop Protection			37,088	0	0	37,088
Crop Protection Center			32,123	21,415	21,415	74,953
Forecasting Laboratory			43,650	29,100	24,250	97,000
Observatory Unit			13,194	8,796	7,330	29,320
Pesticide Laboratory			23,063	23,063	23,063	69,189
			(149,118)	(82,374)	(76,058)	(307,550)
Vehicle						
Dir. of Food Crop Protection			7,500	0	0	7,500
Food Crop Protection Center			35,670	23,780	23,780	83,230
Forecasting Laboratory			39,510	26,340	21,950	87,800
Observatory Unit			8,505	5,670	4,725	18,900
Pesticide Laboratory			3,256	3,256	3,256	9,768
			(94,441)	(59,046)	(53,711)	(207,198)
Training						
Technical Training			10,000	10,000	10,000	30,000
			(10,000)	(10,000)	(10,000)	(30,000)
Land						
Food Crop Protection Center			375,000	250,000	250,000	875,000
Forecasting Laboratory			157,500	105,000	87,500	350,000
Pest Observatory Unit			22,500	15,000	12,500	50,000
Pesticide Laboratory			50,000	50,000	50,000	150,000
			(605,000)	(420,000)	(400,000)	(1,425,000)

(Unit: '000 Yen)

Description	First Year	Second Year	Third Year	Fourth Year	Fifth Year	Total
O/M						
Food Crop Protection Center			159,000	106,000	106,000	371,000
Forecasting Laboratory			56,250	37,500	31,250	125,000
Observatory Unit			45,000	30,000	25,000	100,000
Pesticide Laboratory			25,000	25,000	25,000	75,000
			(285,250)	(198,500)	(187,250)	(671,000)
Sub-Total	0	0	4,415,295	2,958,583	2,690,307	10,064,185
Consulting Services	160,000	106,000	78,000	56,000	48,000	448,000
	(160,000)	(106,000)	(78,000)	(56,000)	(48,000)	(448,000)
Physical Contingency (15%)	24,000	15,900	673,994	452,187	410,746	1,576,827
	(24,000)	(15,900)	(673,994)	(452,187)	(410,746)	(1,576,827)
GRAND TOTAL	184,000	121,900	5,167,289	3,466,770	3,149,053	12,089,012

Cost Escalation is excluded.
Equipment are identified in Table 31.

VII. Project Evaluation

A. General

The Project has been formulated to strengthen the network of rice pest forecasting and control system, and to extend adequate technology of pest control to the farmers through the network of the Government agencies concerned.

The objective of the Project is to reduce rice pest damage in the target provinces, namely 9 provinces shown in Table 32-a, within the framework of the Rice Intensification Programme in Indonesia. To achieve this objective, a Master Plan has been formulated to provide buildings and related facilities, communication system, equipment, training component, etc. as mentioned in VI of this report.

B. Effects of Project Implementation

During the course of its implementation, the Project will have favorable effects on rice pest forecasting and control systems in the following manner.

1) To provide earlier information concerning period and cycle of pest appearance and numerical abundance of pests;

2) to provide earlier information concernig types of pesticide applicable, timing of pesticide application and its frequency;

3) to enable an earlier preparation of the distribution plan of pest control materials (pesticides, pest control machines, etc.) and a mobilization plan of pest control personnel;

4) to ensure quick and adequate action against the explosion of pest appearance;

5) to enable the formulation of new technology of pest control as a result of elaborate analyses of the accumulated data and information; and

6) to enable quick action of institutional and technological measures for pest control at the national level.

As a result of these effects, rice pest damage will decrease to a certain extent and will in turn increase the production of rice crop in the targeted provinces of the Project.

C. Economic Benefits

As described above, the economic benefits from the Project will mainly accrue from the increased rice production as a result of decrease of rice pest damage.

As shown in Table 33, paddy rice production "without Project" has been calculated on the basis of the Estimated Hectare Yield Curve (Fig. 43) with the assumption that rice pest damage will be about 20% annually throughout the Project life.

Paddy rice production "with Project" has been calculated on the basis of the estimated decrease of pest damage of (i) 0.1% at 6th year from the commencement of the Project, (ii) 0.5% at 16th year and (iii) 1.0% at 31st year.

The total incremental benefits of the Project are US$3,933 million as shown in Table 33.

D. Economic Costs

The economic costs of the Project take into account all investment costs including contingency expressed in 1982 constant prices over the life span of the Project, and operation and maintenance costs as shown in Table 34. The economic costs exclude price escalation, and no residual value has been assumed.

E. Economic Internal Rate of Return

In the economic evaluation of this sector, Rupiah and Yen are converted to US Dollar at the exchange rate of Rp.650 to US$1.00 and ¥250 to US$1.00. The Project life for the economic evaluation has been fixed at 50 years.

On the basis of the direct costs and benefits described above, the Project is expected to yield an EIRR of 22.82% (Table 35).

The major assumptions underlying the EIRR calculation are; (i) a Project economic life of 50 years; (ii) paddy rice is valued at Rp.135,000 or US$208 per ton which is almost equivalent to the world market price of Thai rice as shown in Table 36; (iii) 0.1% decrease of pest damage at 6th year, 0.5% decrease at 16th year and 1.0% decrease at 31st year; and (iv) an implementation period of 5 years.

F. Sensitivity Analysis

Sensitivity analysis has been made on the assumptions of; (i) increase of investment costs by 10%; and (ii) less decrease of pest damage.

The results are summarized below:

		EIRR
1)	Increase of investment costs by 10%	21.85%
2)	less decrease of pest damage (0.1% at 6th year, 0.2% at 16th year and 0.5% at 31st year)	18.63%

VIII. Allocation of Project Costs

Total Project costs amount to ¥12.08 billion including a local currency component of about ¥7.45 billion and foreign currency of ¥4.63 billion. Allocation of the Project costs may be broken down by the foreign currency and local currency as follows:

Description	Total Amount	Local Currency	Foreign Currency
Building and Facilities	6,654,564,000	4,353,362,000	2,301,202,000
Equipment	768,873,000	0	768,873,000
Spareparts	307,550,000	0	307,550,000
Vehicles	207,198,000	0	207,198,000
Training	30,000,000	30,000,000	0
Land Acquisition	1,425,000,000	1,425,000,000	0
Operation and Maintenance	671,000,000	671,000,000	0
Consulting Service	448,000,000	0	448,000,000
Physical Contingency	1,576,827,000	971,904,000	604,923,000
Total	12,089,012,000	7,451,266,000	4,637,746,000

Allocation of Project costs for building and facilities is detailed in Appendix- B.

IX. Comments & Recommendations

1. Supporting Structures for the Project
   This Project includes construction of buildings for Food Crop Protection Center, Pest Forecasting Laboratory and Pest Observatory Units, and purchase of equipment for these institutions which have a minimum capacity to undertake pest forecasting and control schemes in Indonesia. These facilities may become the core of this Project and therefore are designed to modify and/or create adequate results on a minimum scale.

2. Main Objective of the Project
   Prioritive importance of this Project is to improve the technical level of officials by educating more officials in appropriate technical knowledge. To achieve this objective, technical training programmes with original curriculums and laboratory equipments arranged at Directorate of Food Crop Protection, Crop Protection Center and Pest Forecasting Laboratory and preparation of appropreate manuals will be carried out.

3. Location and Number of Food Crop Protection Center
   In determing location and number of Food Crop Protection Center to be built, first roughly select several possible places considering many factors such as pest damage condition, productivity of rice, distribution, geographic conditions, transporting means and communication network. Then, determine possible locations and number in view of the assumed practical effect.

4. Location and Number of Pest Forecasting Laboratory
   Pest Forecasting Laboratory should be able to carry out field observations and experiments to meet pest forecasting and control problems at the Kabupaten level. Location and number should be finalized after analytical conclusion on pest conditions, rice planting practices, and local rice economy is obtained.

5. Activity at Pest Observatory Unit
   Pest Observatory Unit should be able to carry out field observation at the Desa level. Pest forecasting and control activity will be undertaken in view of current confronting pest problems.

6. Utilization of Crop Protection Brigade

Crop Protection Brigade normally consists of five members. Statistical data in West Java shows that 290 crop protection groups with 3,205 members operated in 1974 and in 1979 this increased to 2,692 crop protection groups with 22,820 members. Average members per group were 11.0 and 8.5 respectively.

Consequently, it may not be difficult to have such men with experience in pest control regularly located at Food Crop Protection Center and Pest Forecasting Laboratories. Their normal function is to undertake basic and applied tests concerning pest damage problems. Once required to take action, they are to perform instructive work and control tasks for the pest control.

7. Spray Equipment

Statistical data by the Brigade in West Java during the period of 1974 to 1979 shows that trouble occurence percentage of newly provided pest control equipment was about 50% in the second year and about 80% in the third year. Old equipment appears to be replaced every three years. To ensure better repairing efficiency, it may be necessary to replace one third of the old equipment with new every successive year.

8. Maintenance of Spray Equipment

High percentage of the trouble occurence may be largely due to inadequate procedure after use. In particular, all troubles of mist blowers occur in the air cleaner. Occurance of the problem may be reduced if the air cleaner which is fouled with solvent or mixed fuel oil is cleaned after each use by using a synthetic cleanser.

APPENDIX - A

FIGURES AND TABLES

FIGURES

TABLES

Fig. 1 Distribution of Meteorological Stations Belonged to Weather Bureau

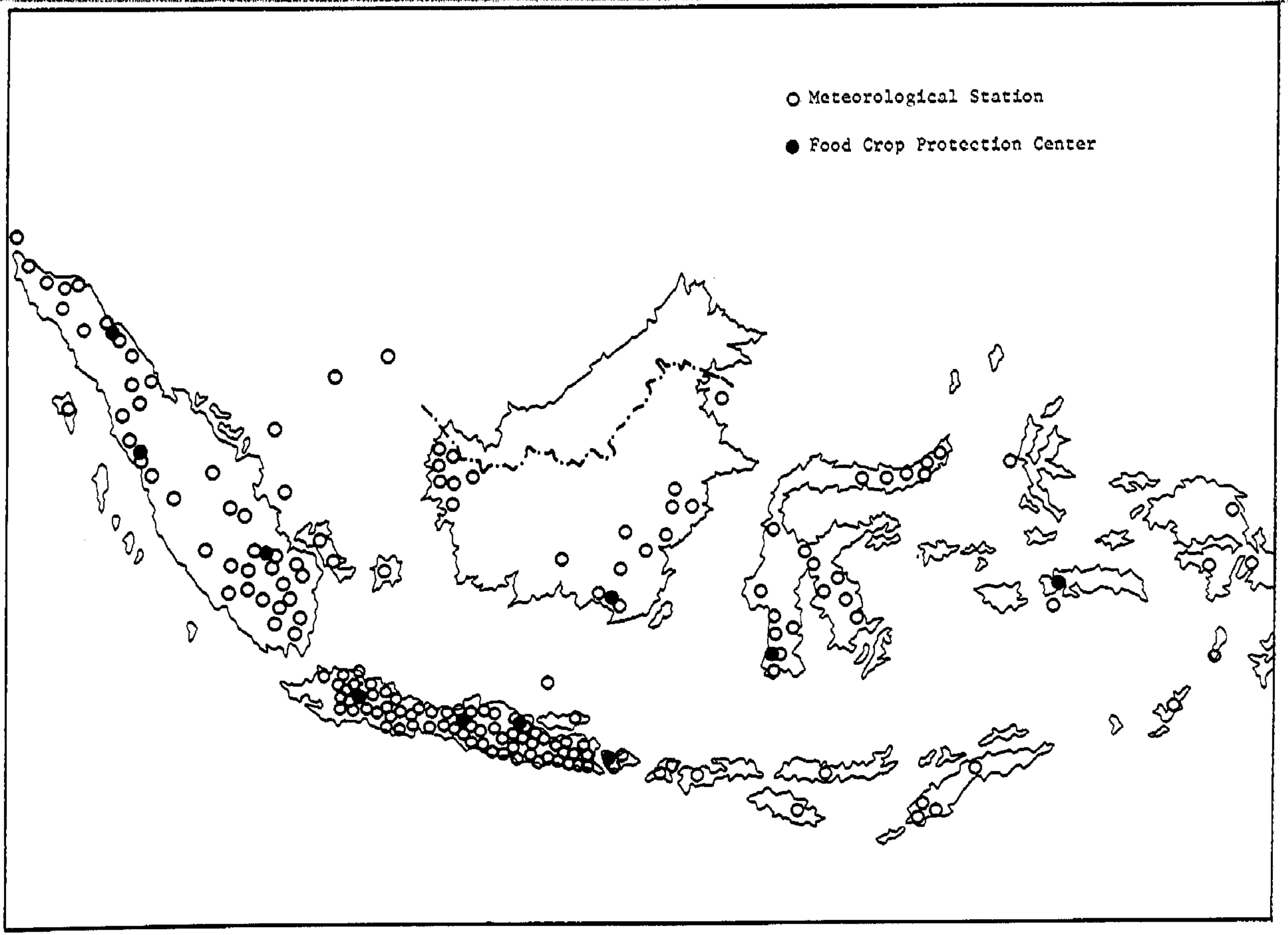


Fig. 2 Distribution of Agro-meteorological Stations belonged to Central Research Institute for Food Crops

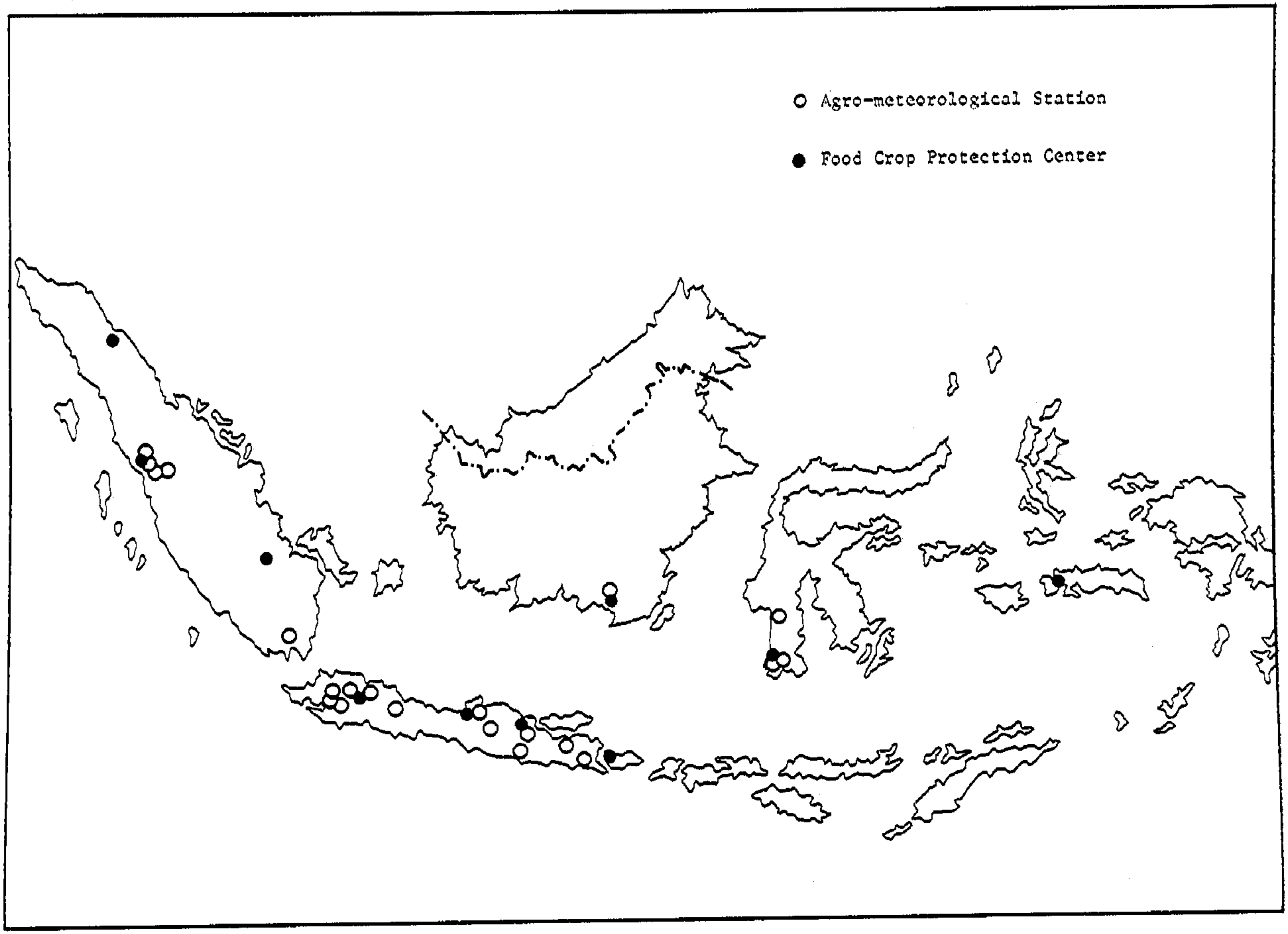


Fig. 3 Wind Direction of Tropical Monsoon During Wet Season

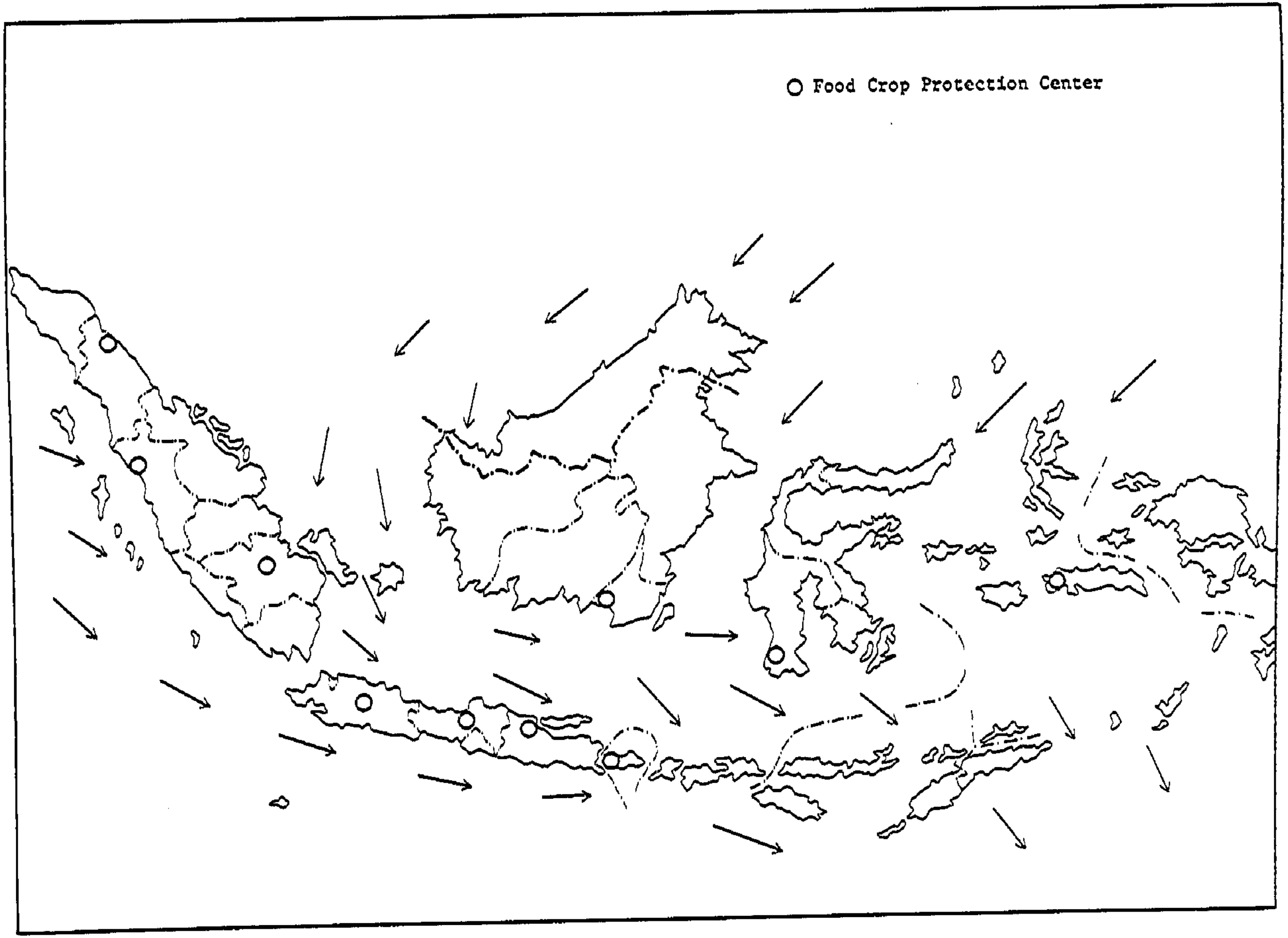


Fig. 4 Wind Direction of Tropical Monsoon During Dry Season

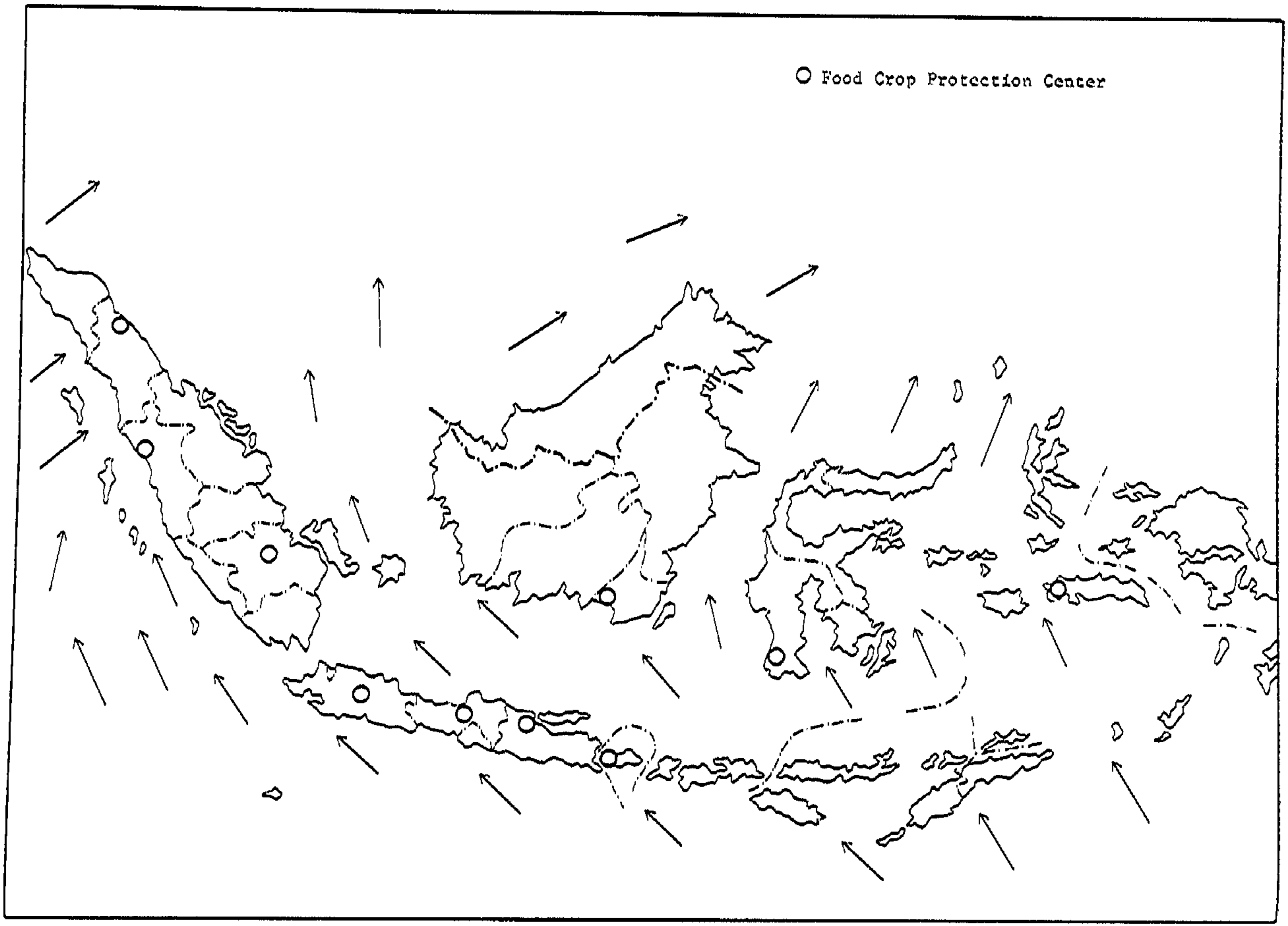


Fig. 5 Priority Destructive Rice Pests by Province in 1978

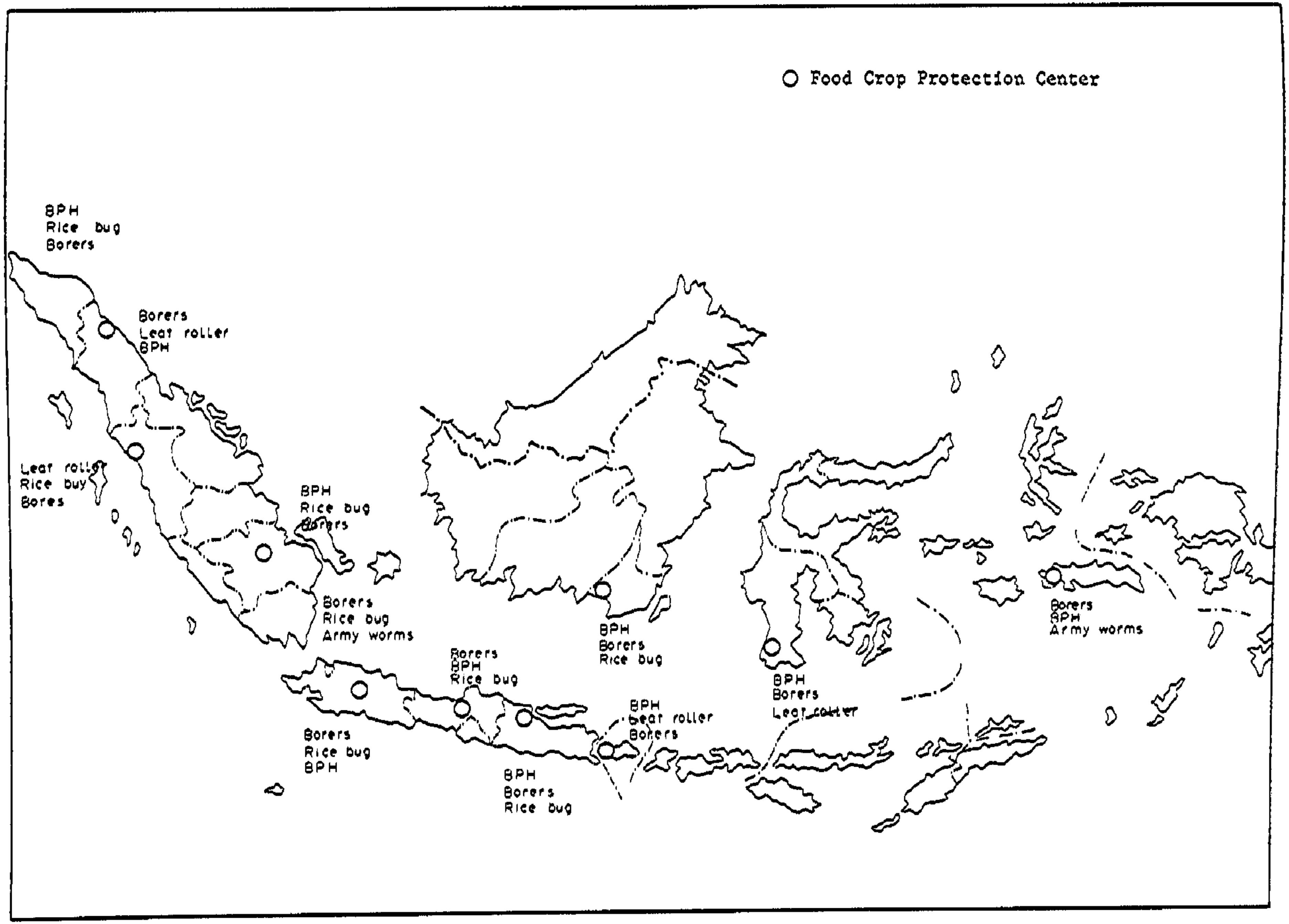


Fig. 6 Priority Destructive Rice Pests by Province in 1980

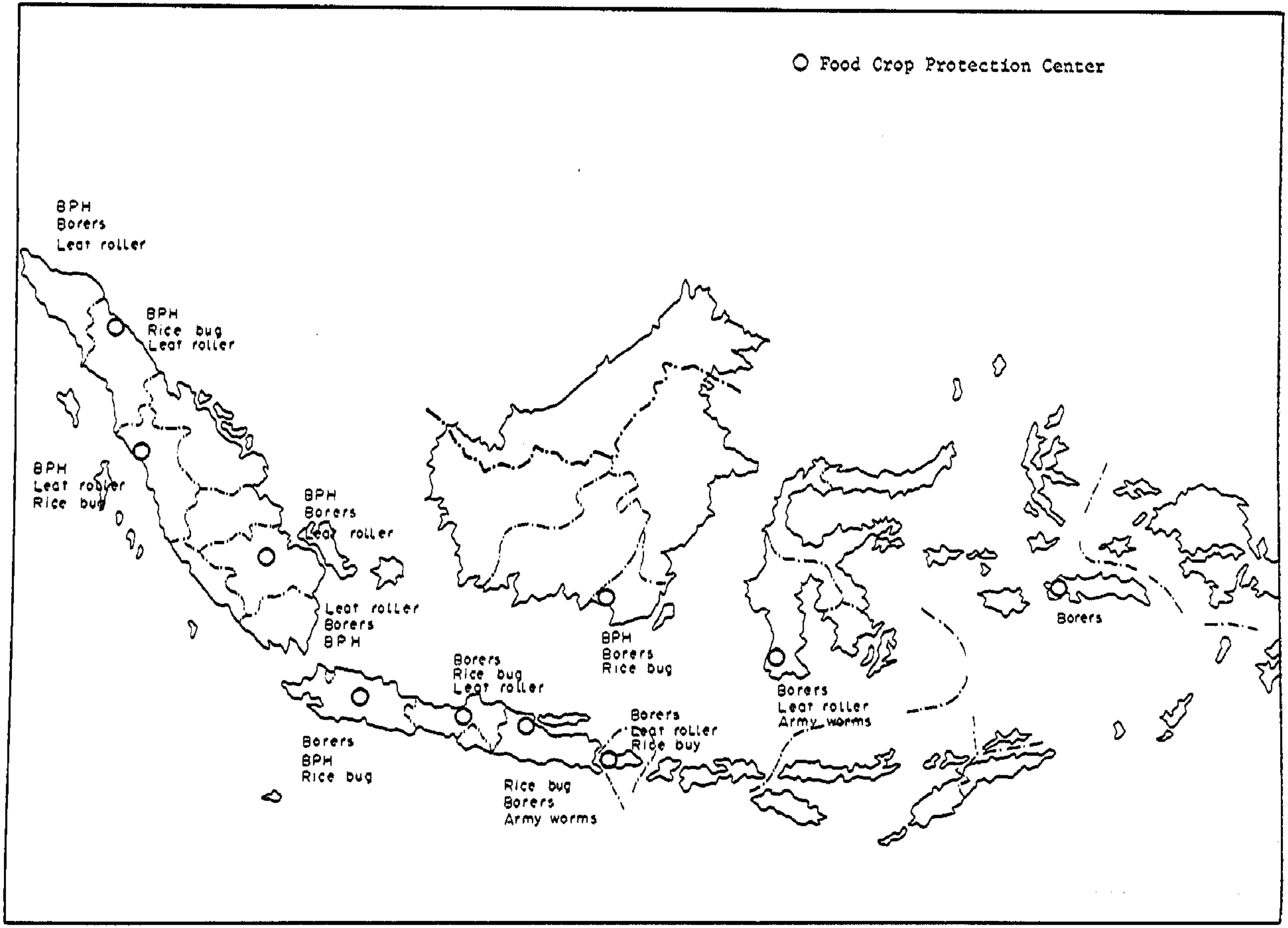


Fig. 7 Priority Destructive Rice Pest by Kabupaten in Aceh Province in 1982

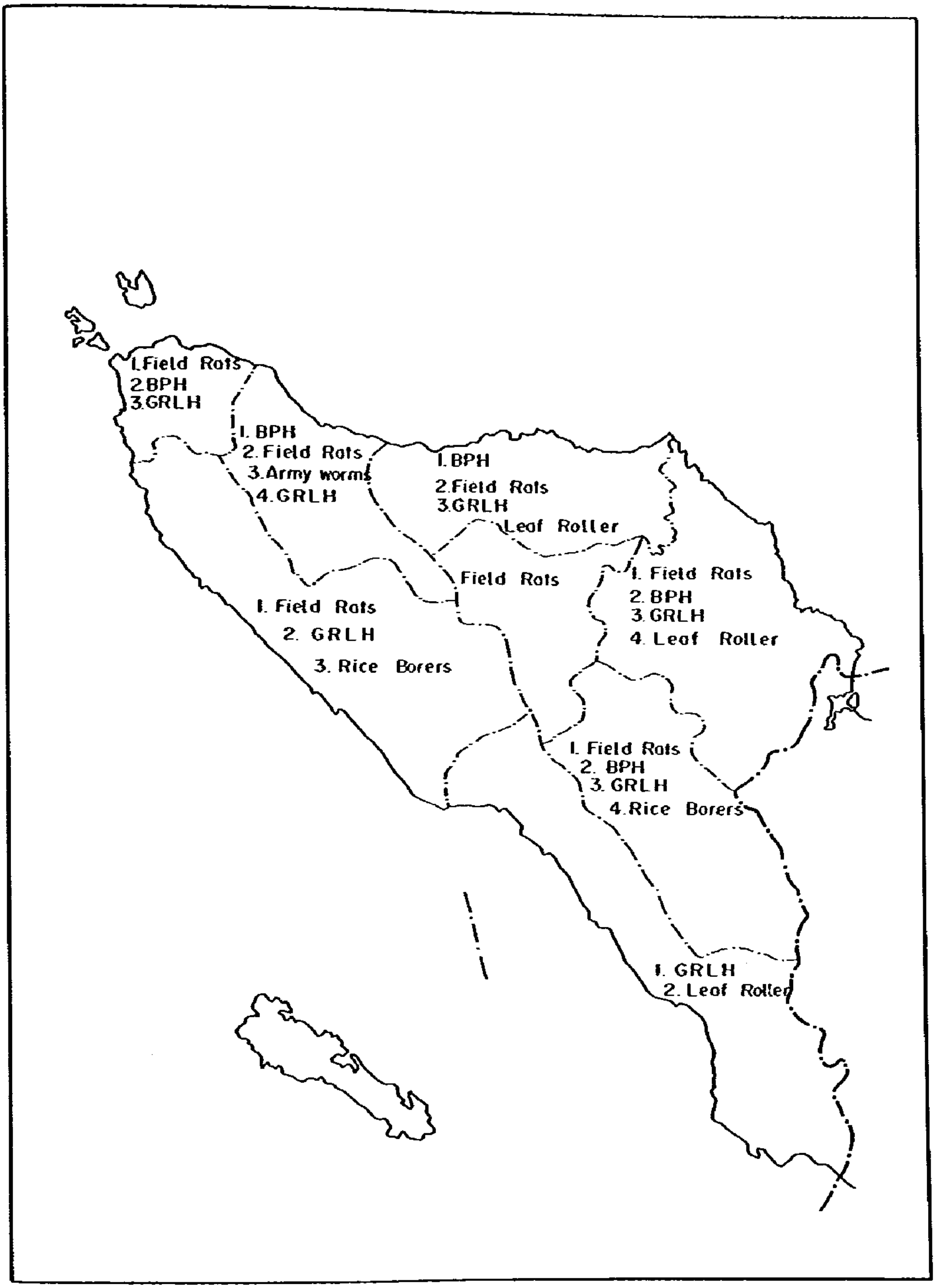


Fig. 8 Priority Destructive Rice Pest by Kabupaten in North Sumatra Province in 1982

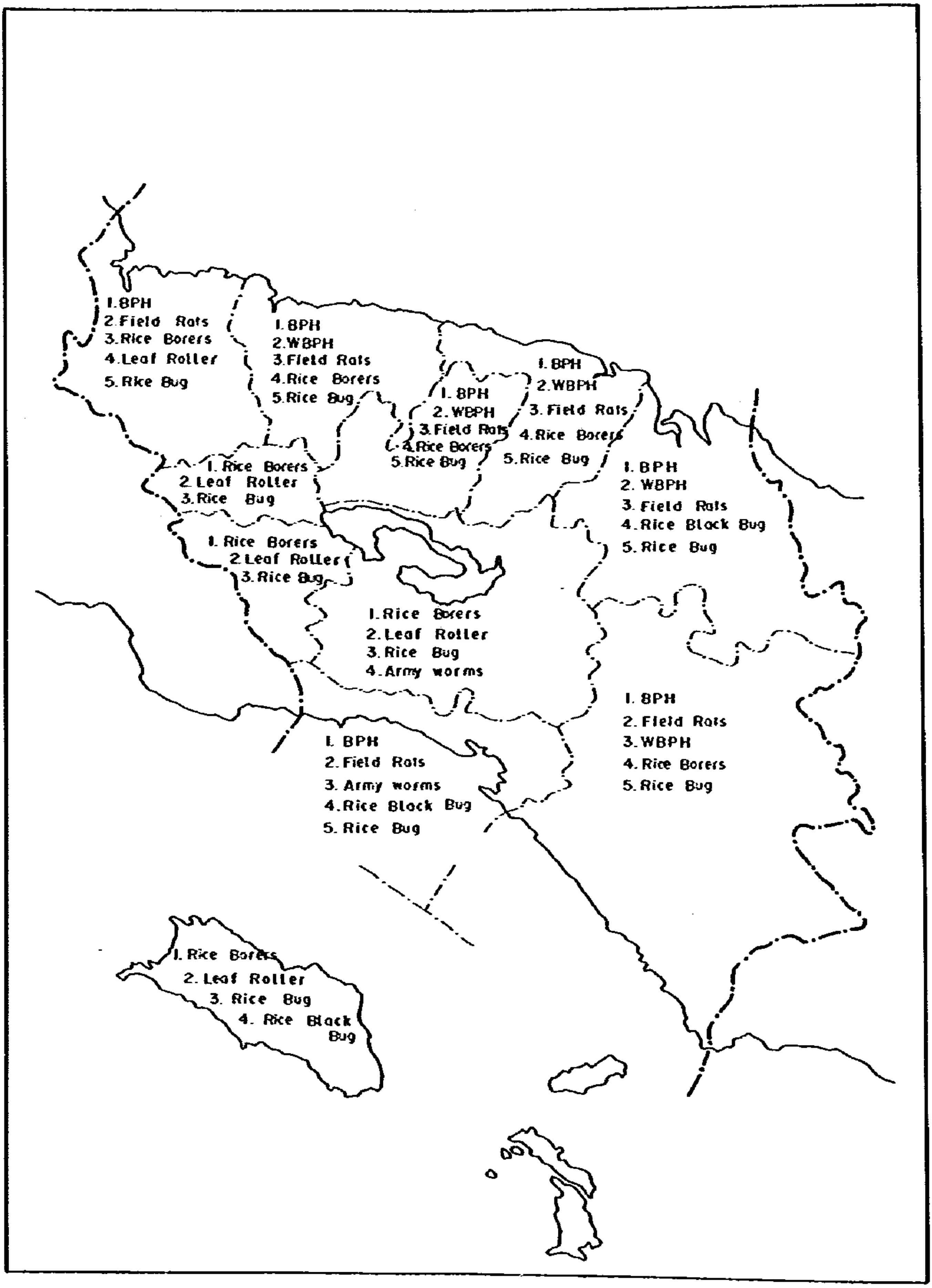


Fig. 9 Priority Destructive Rice Pest by Kabupaten in Lampung Province in 1982

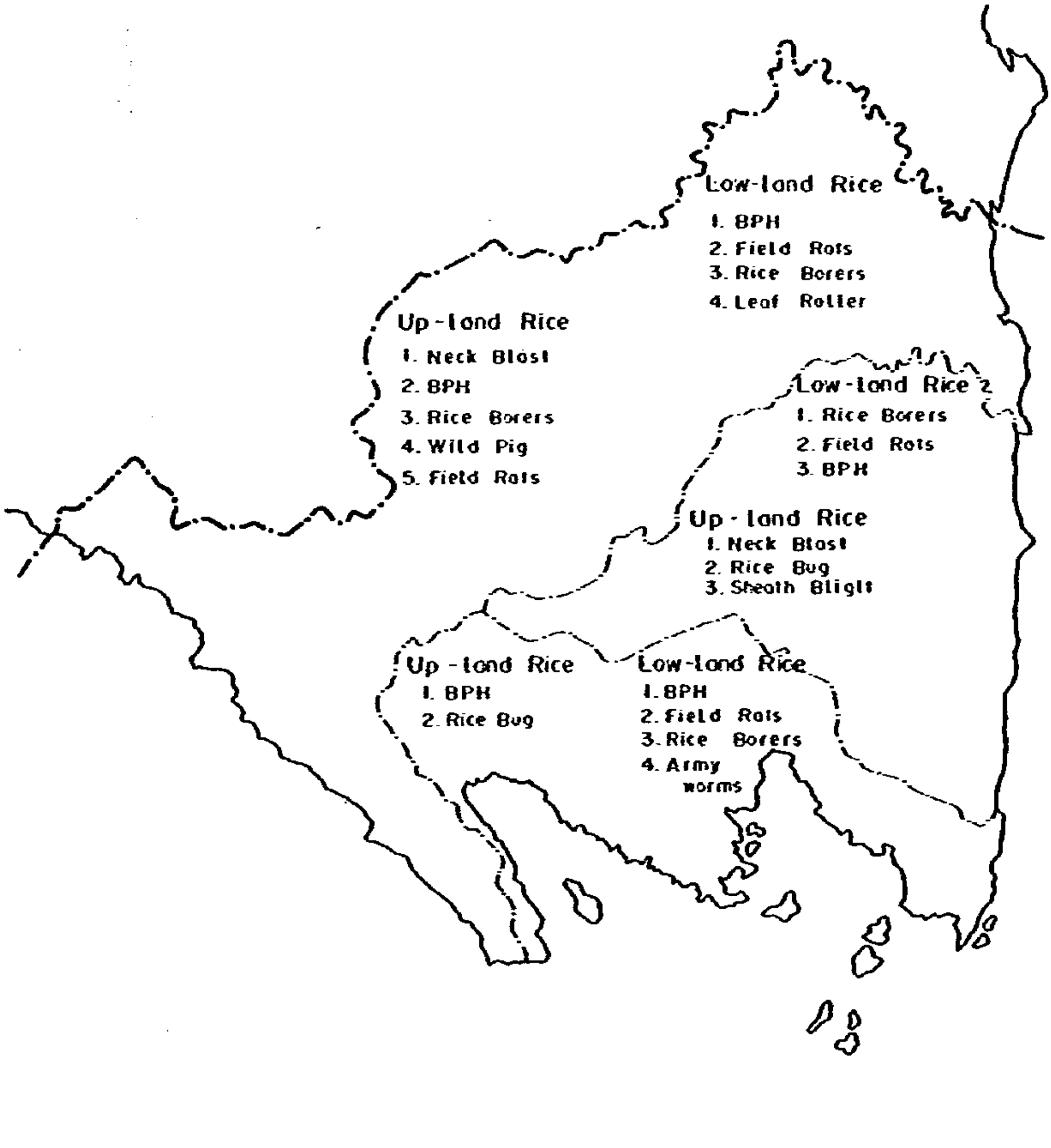


Fig. 10 Relationship Between Major Rice Pest Emergences and Cultivated Areas of Brown Planthopper Resistant Rice Variety in South Kalimantan Province in 1973-1981

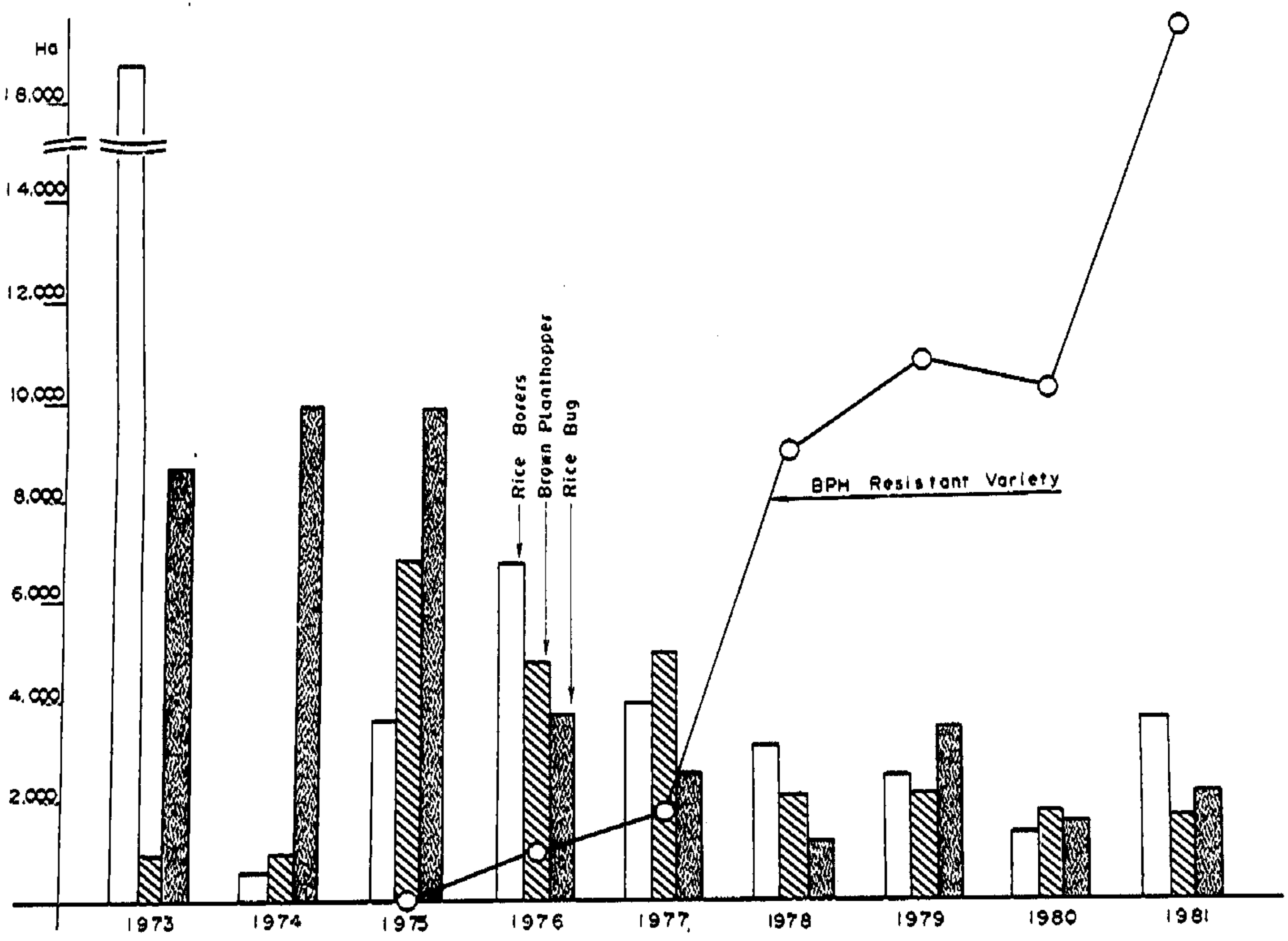


Fig. 11 Progress of Crop Protection Brigade in Number in South Kalimantan Province in 1973-1981

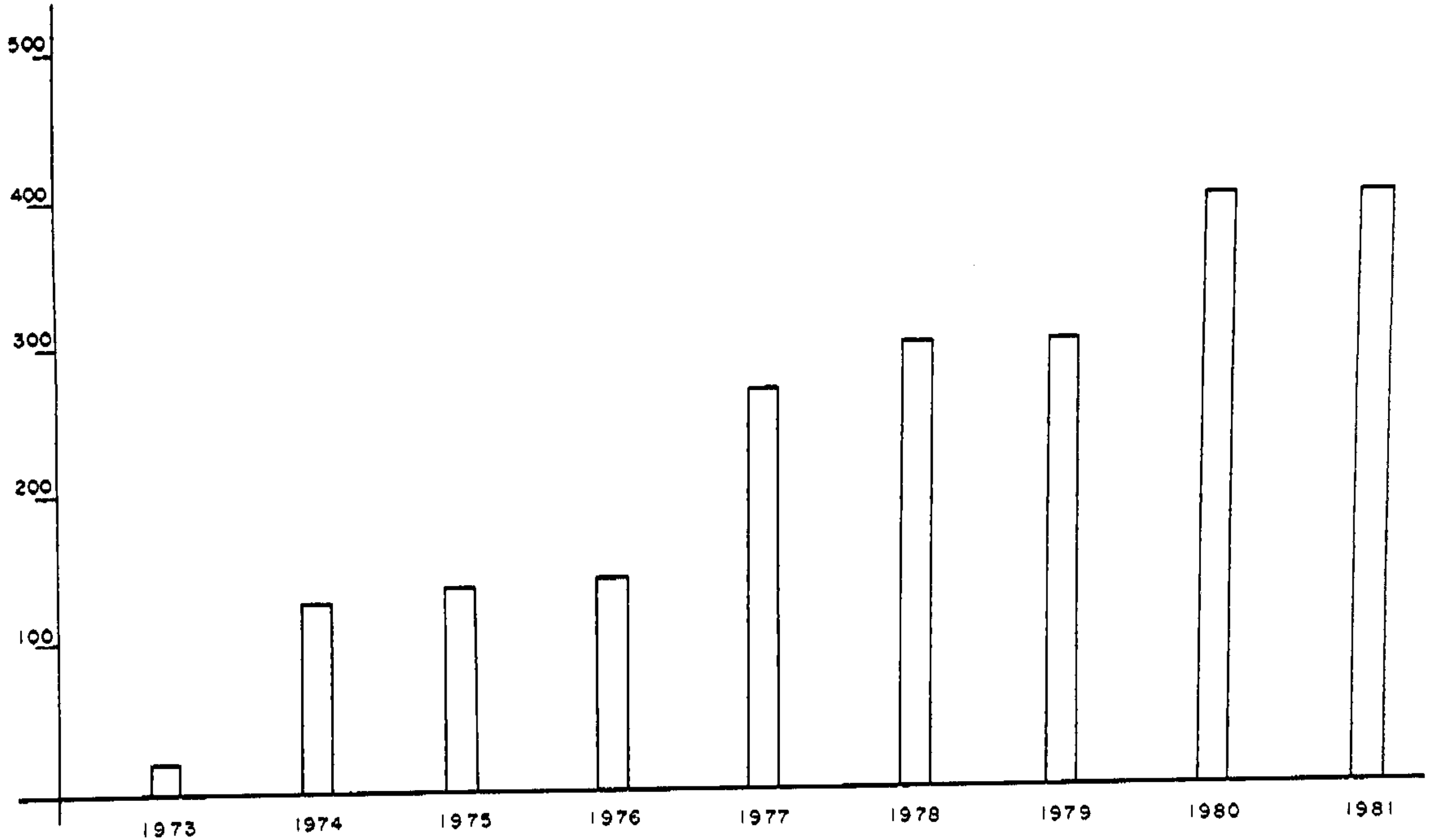


Fig. 12 Monthly Light Trap Catches of Rice Stem Borer Species in East Java Province in 1969-1970

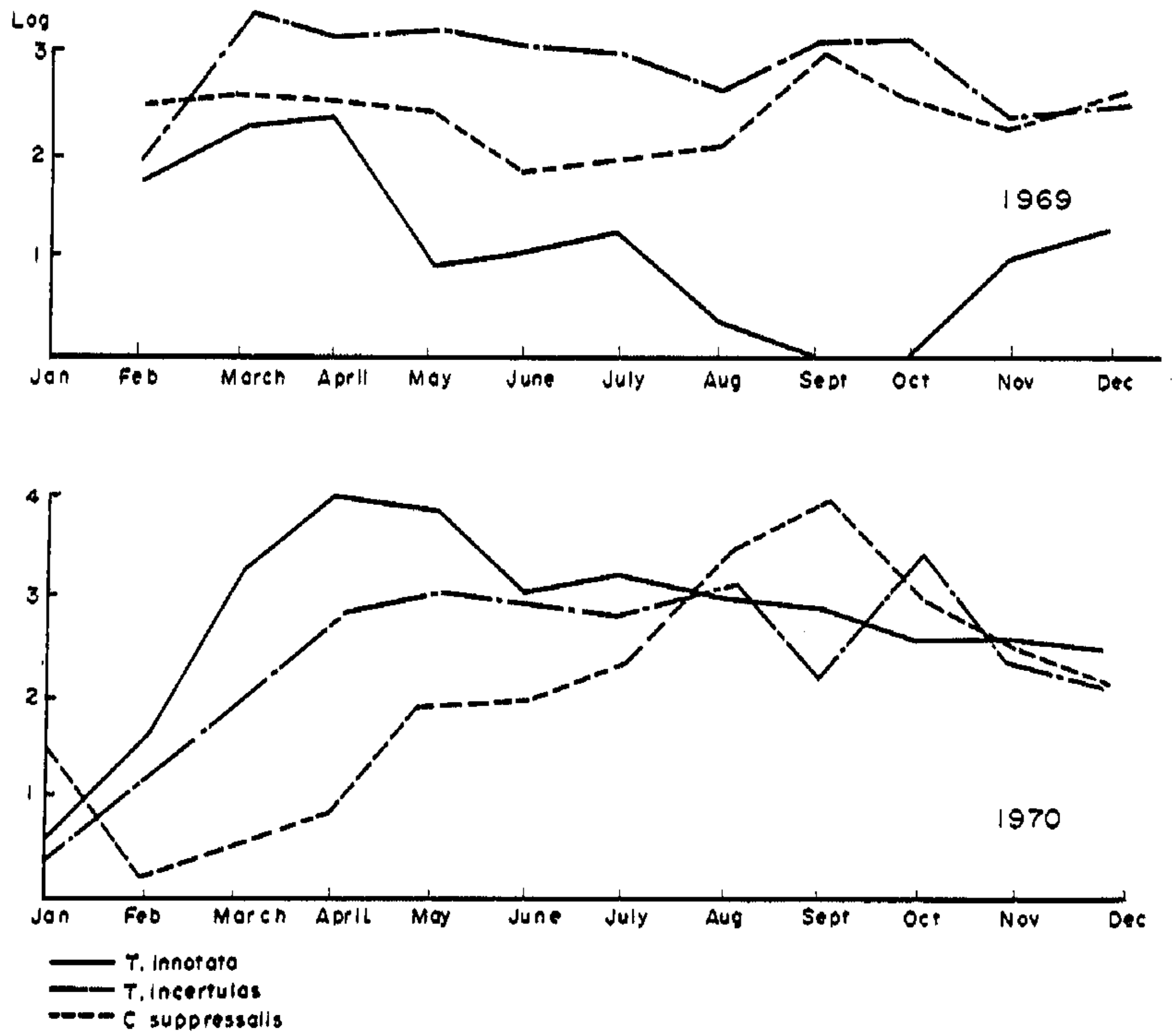


Fig. 13 Comparative Brown Planthopper Catches in Light Trap, Sweeping Net, and Water Pan Trap at Sukamandi Food Crop Research Institute

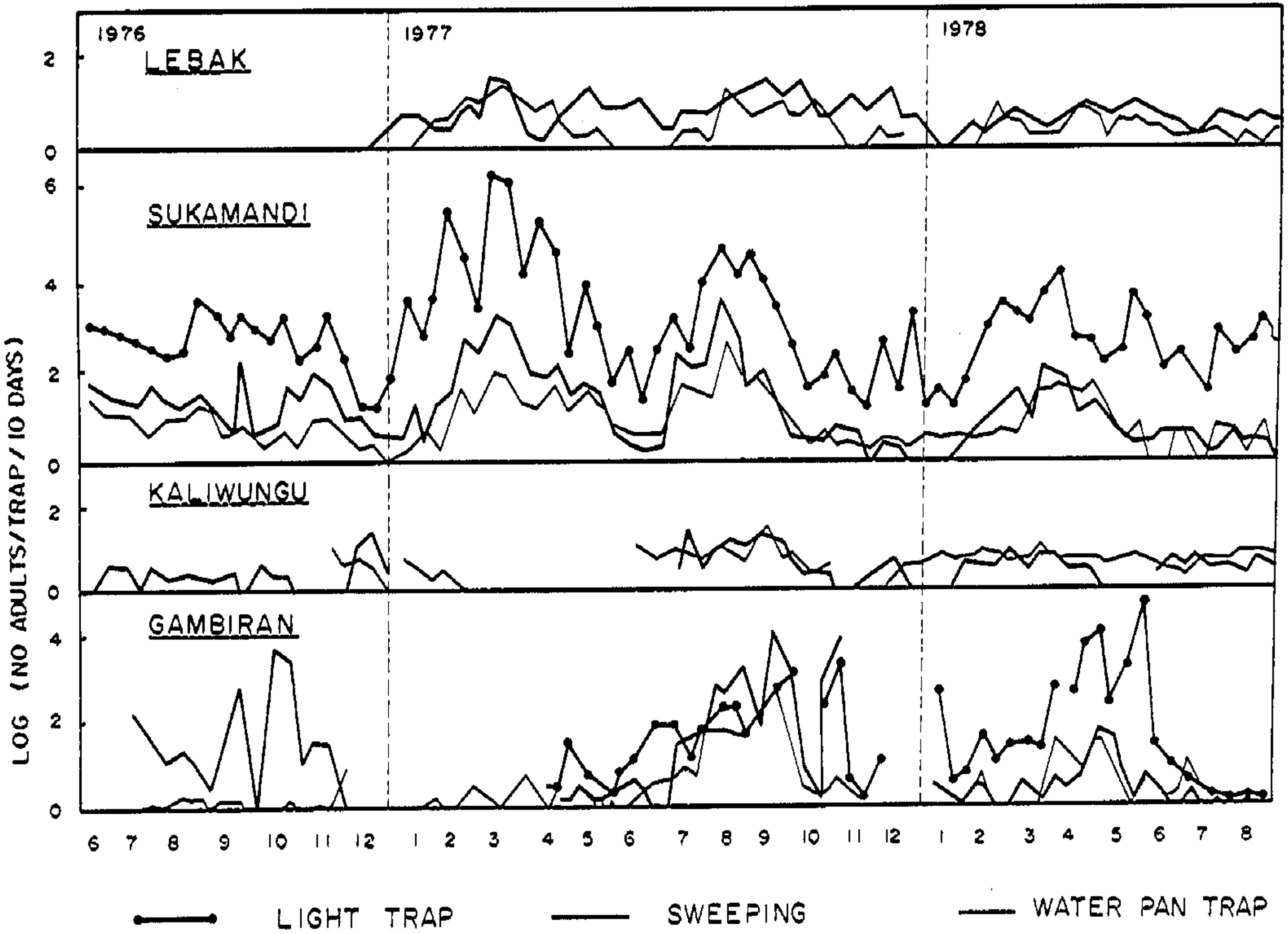


Fig. 14 Light Trap Catches of Rice Gallmidge in East Java Province

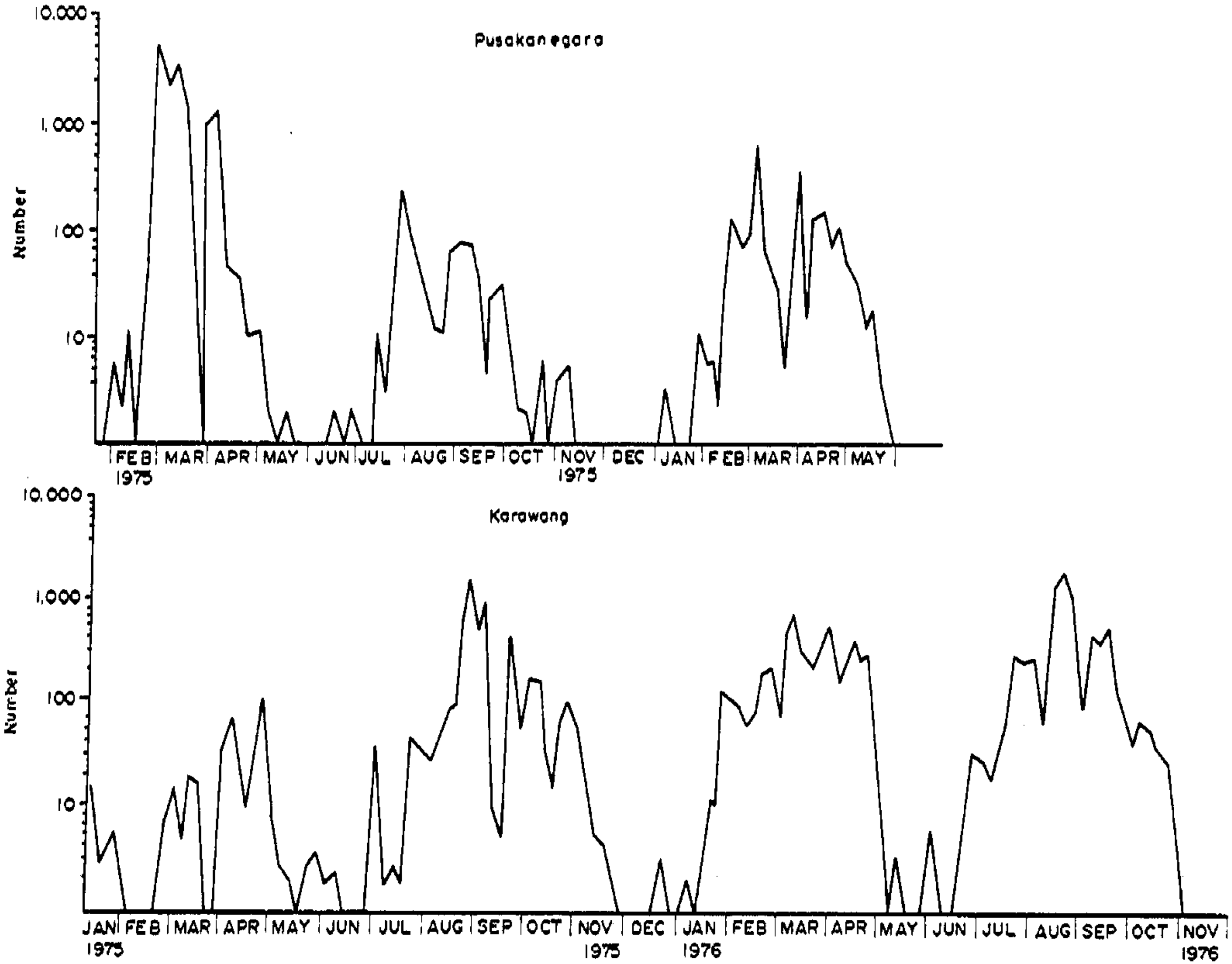


Fig. 15 Soil Map of Aceh Province

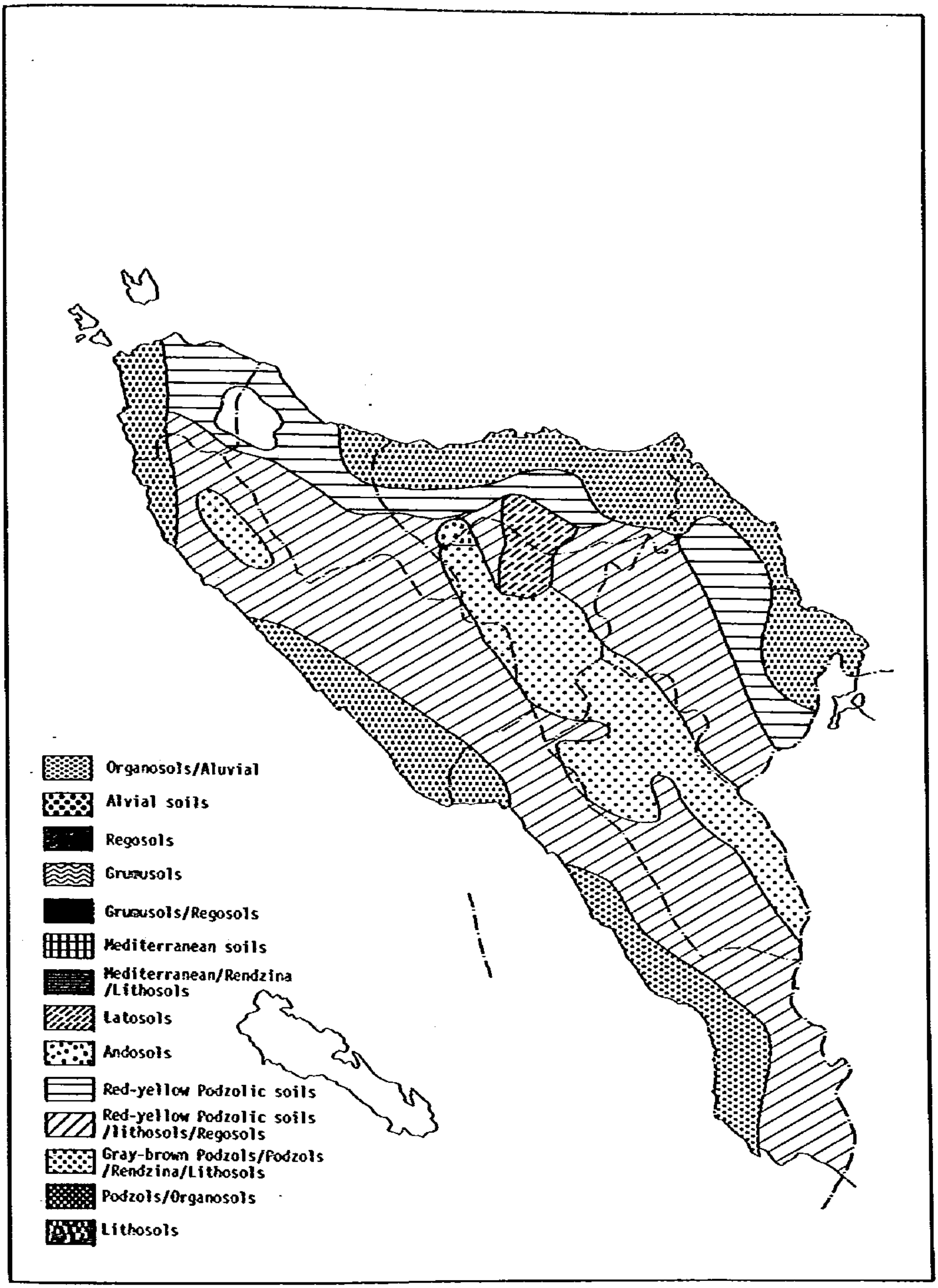


Fig. 16 Soil Map of North Sumatra Province

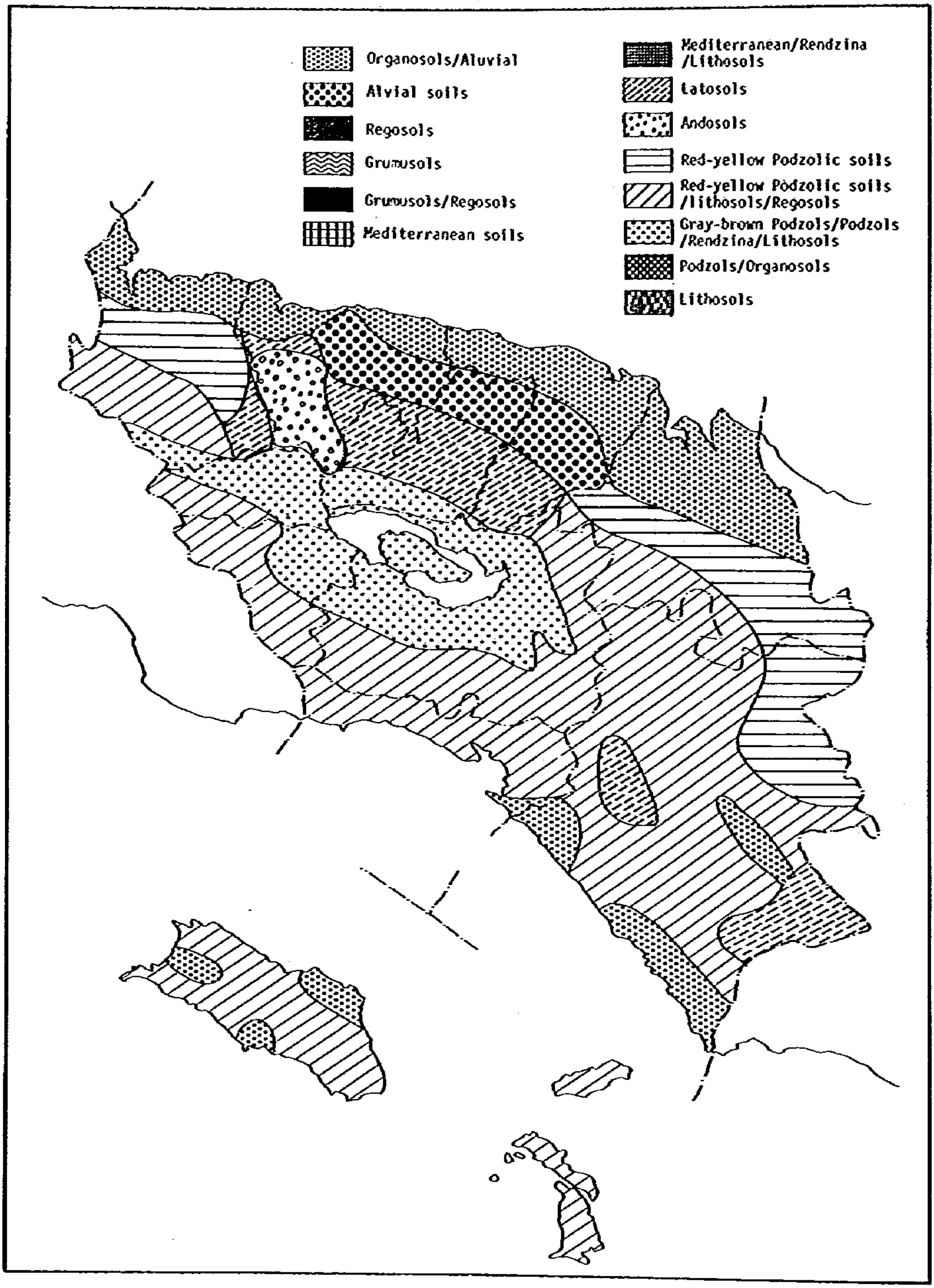


Fig. 17 Soil Map of Lampung Province

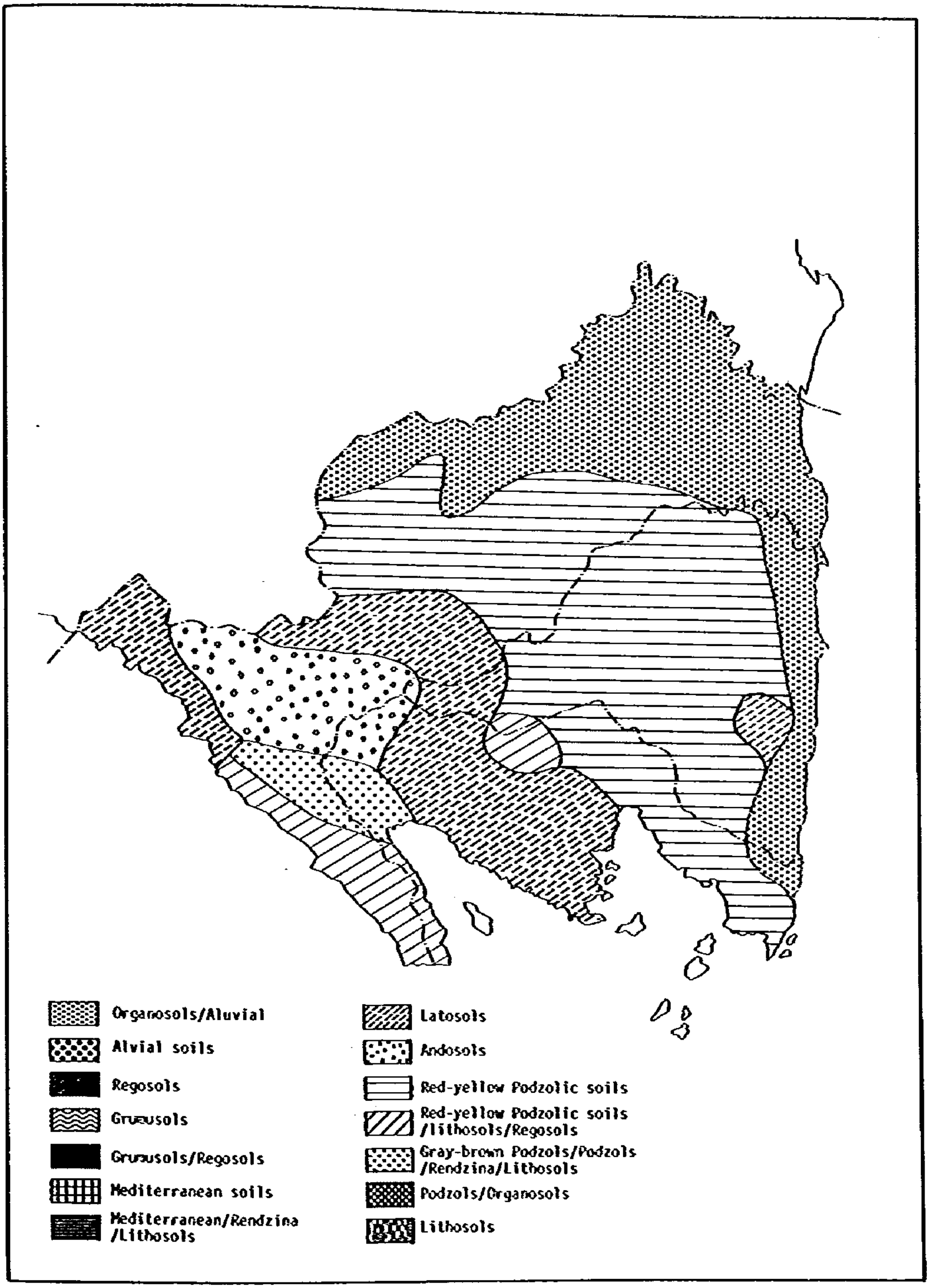


Fig. 18 Soil Map of South Kalimantan Province

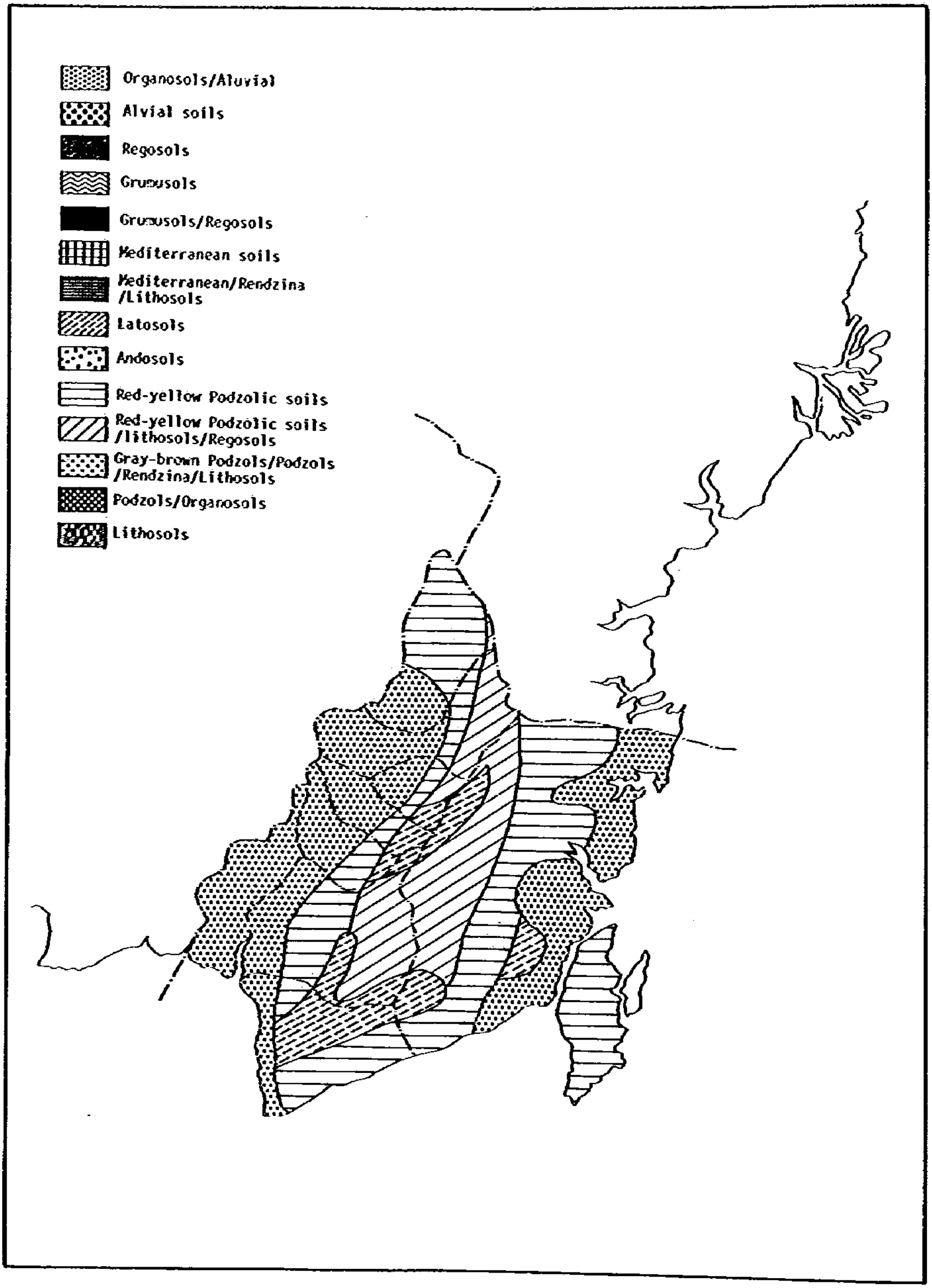


Fig. 19 Soil Map of South Sulawesi Province

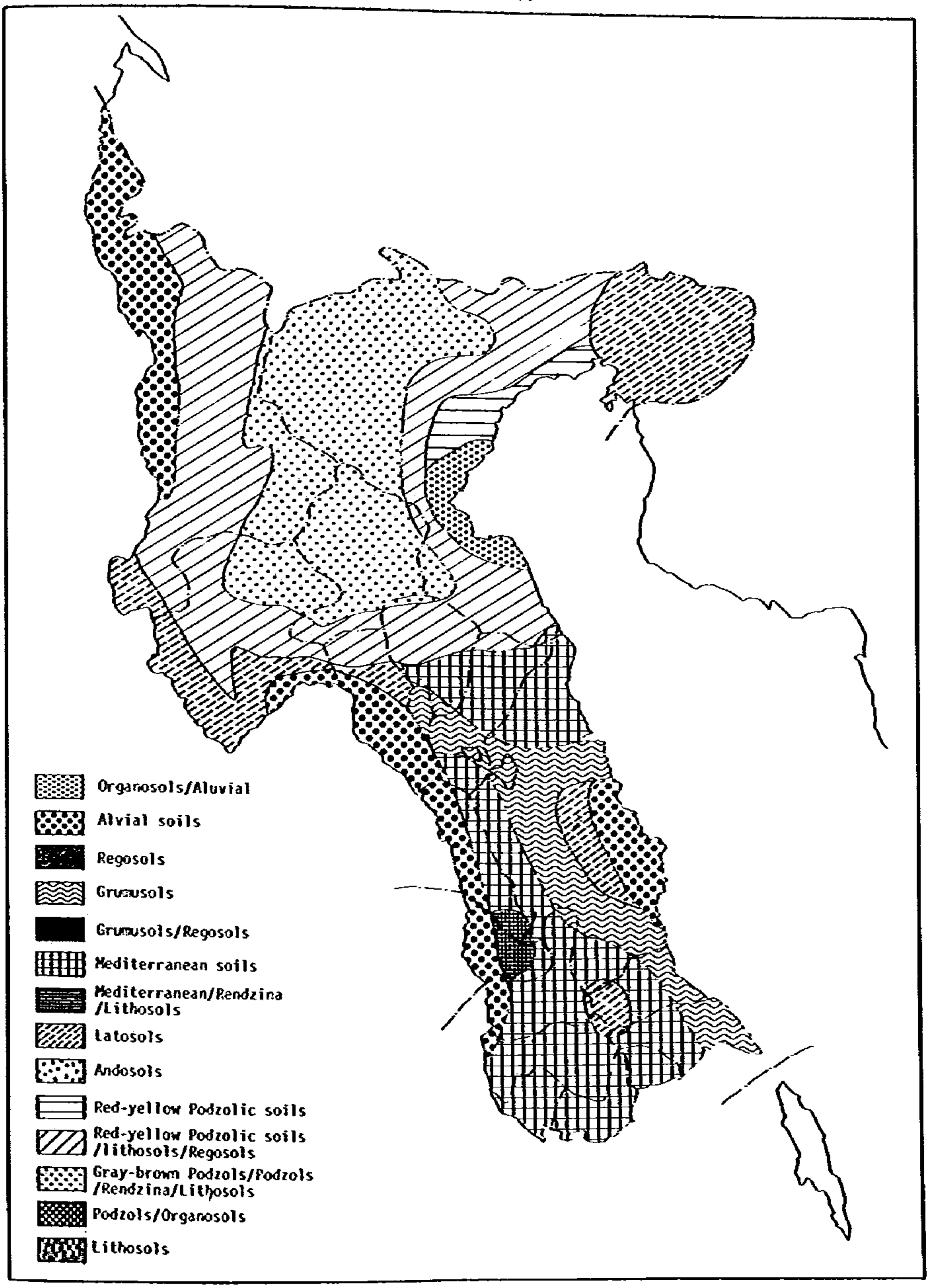


Fig. 20 Soil Map of West Jave Province

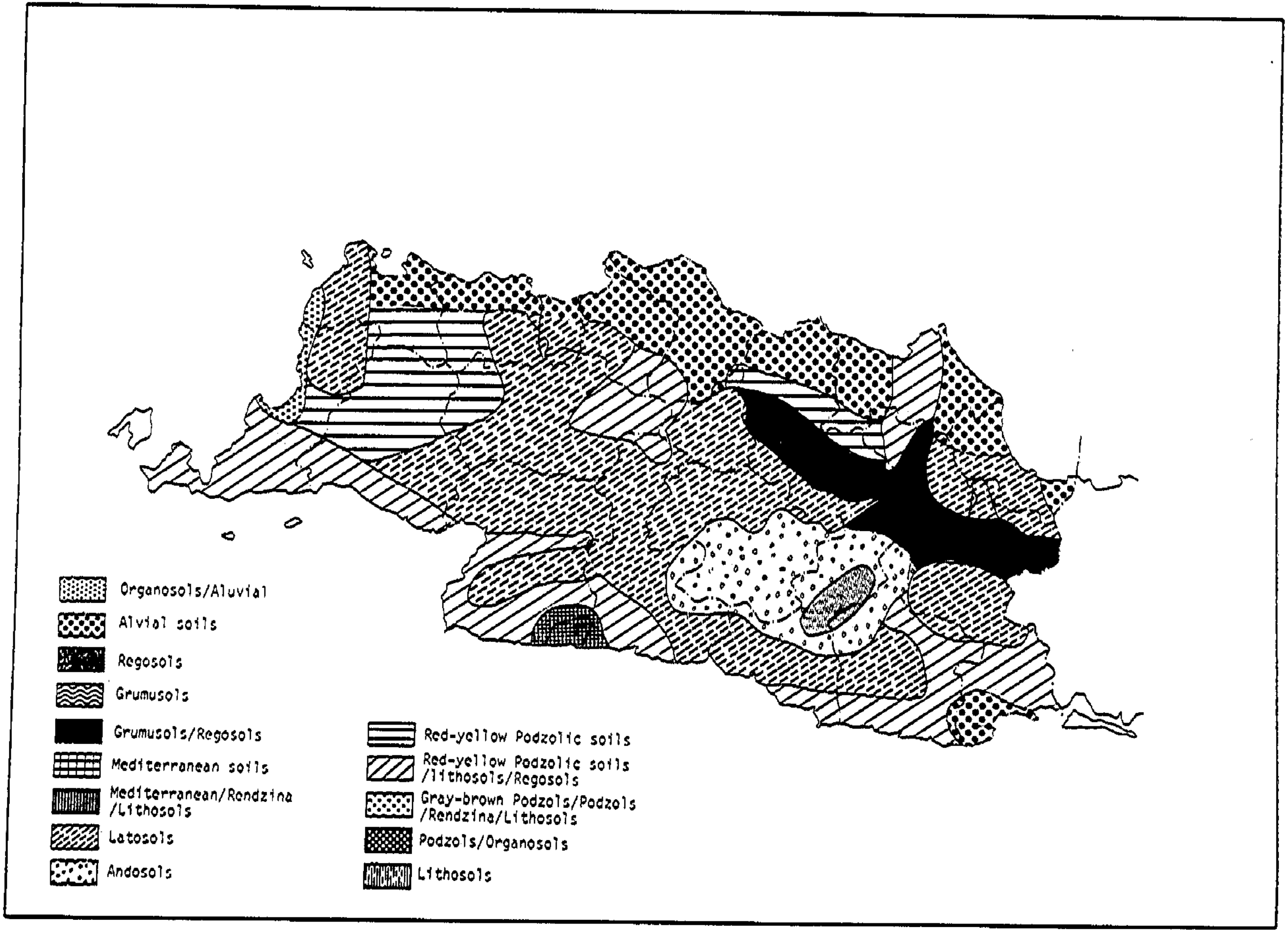


Fig. 21 Soil Map of Central Java Province

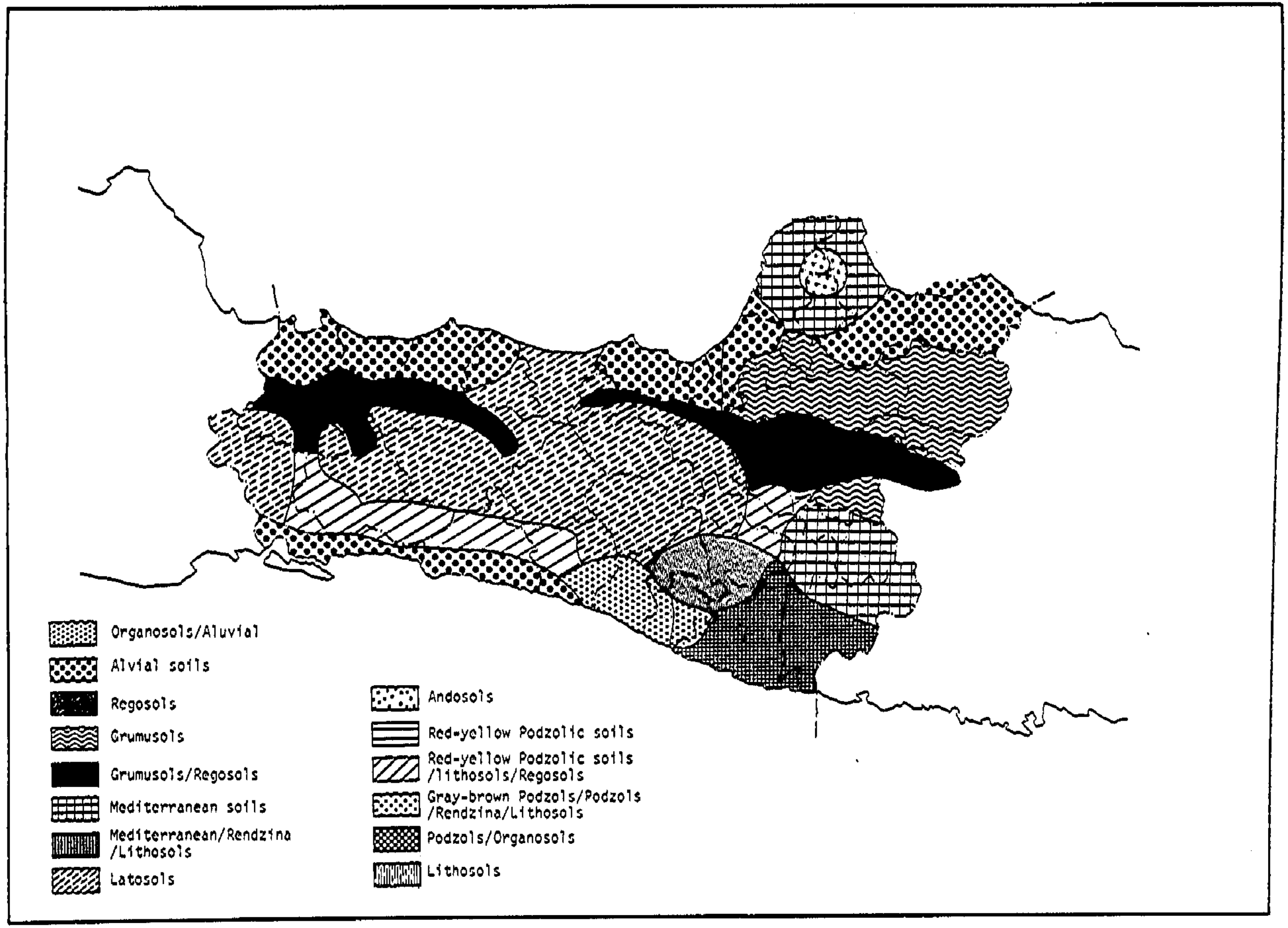


Fig. 22 Soil Map of East Java Province

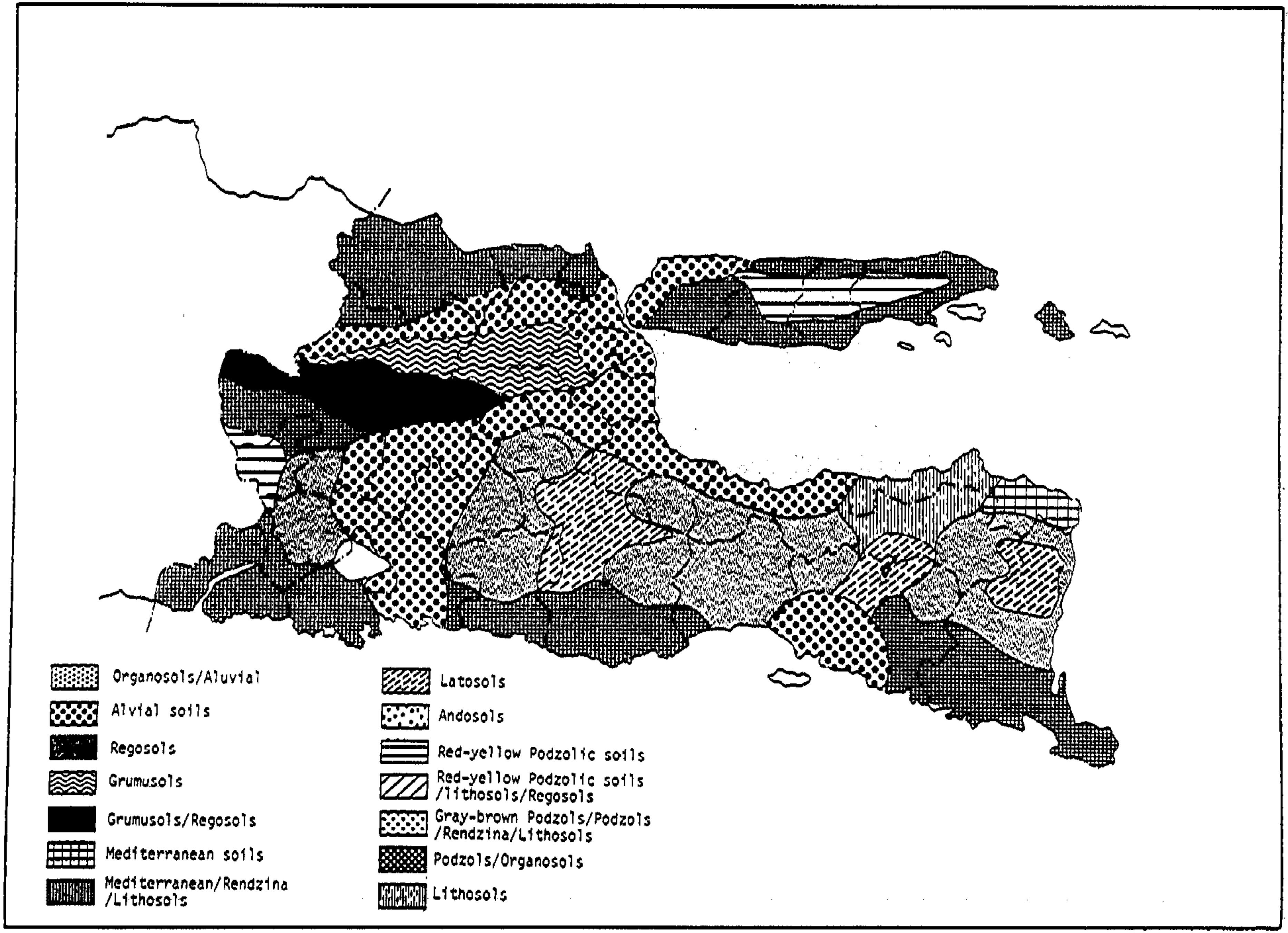


Fig. 23 Central Government Organizational Structure of Rice Protection System

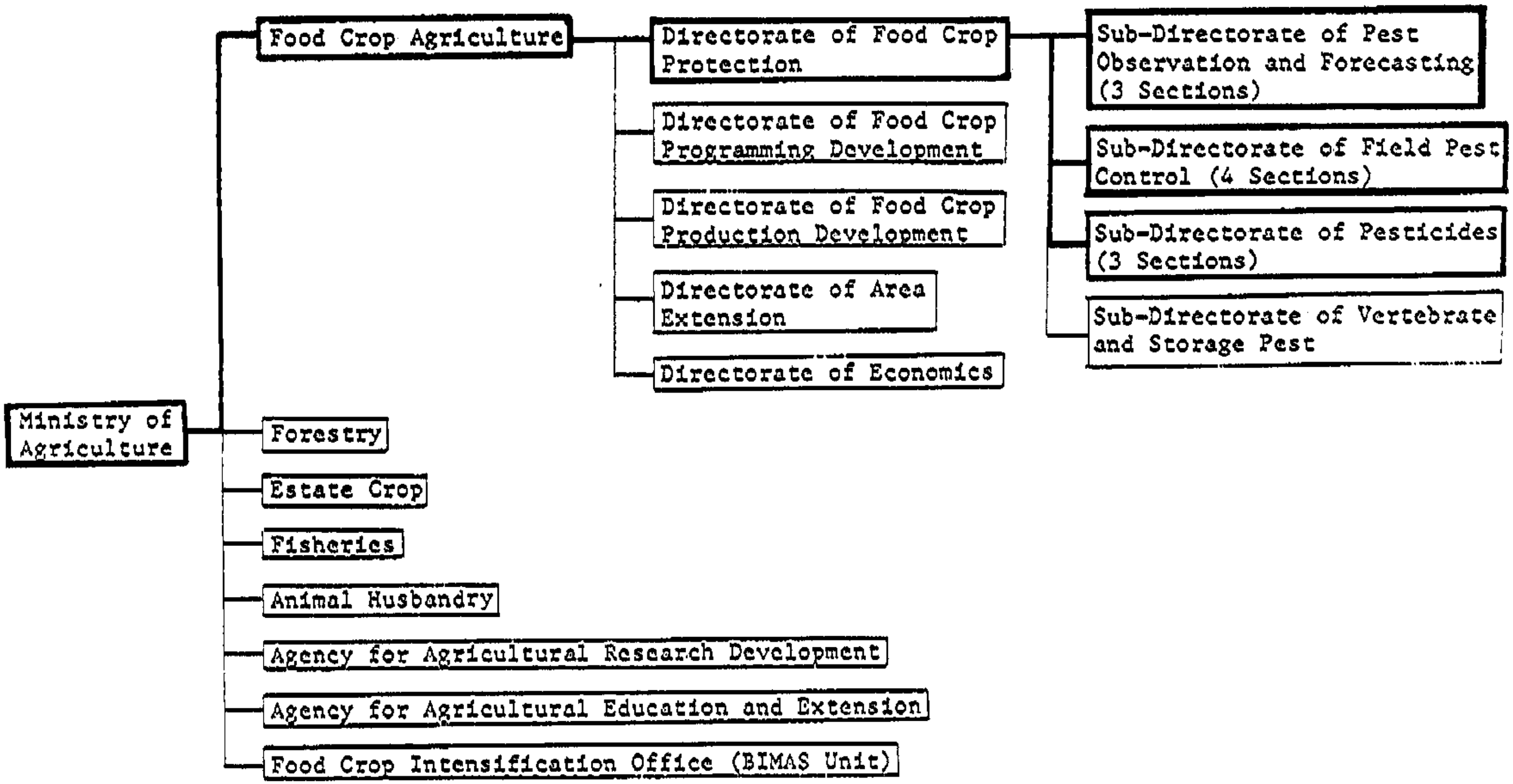


Fig. 24 Regional Government Organization Structure of Directorate of Food Crop Protection

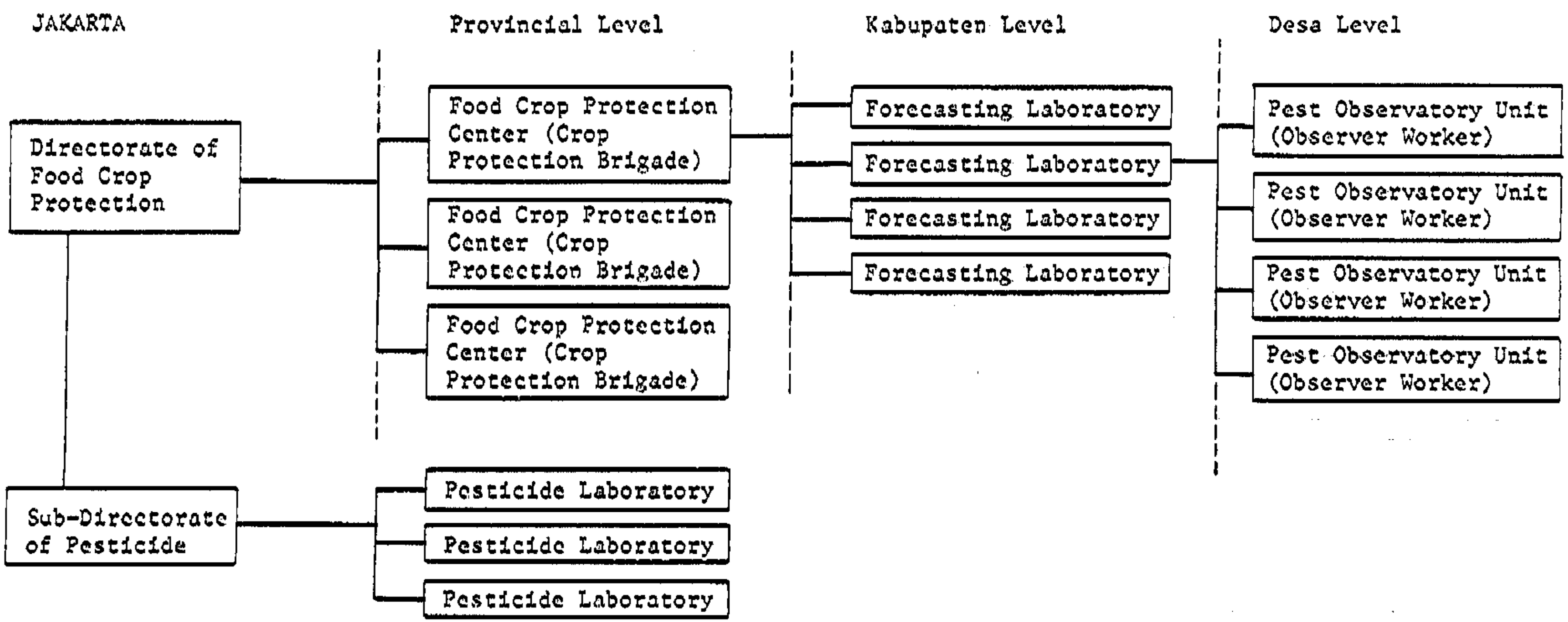
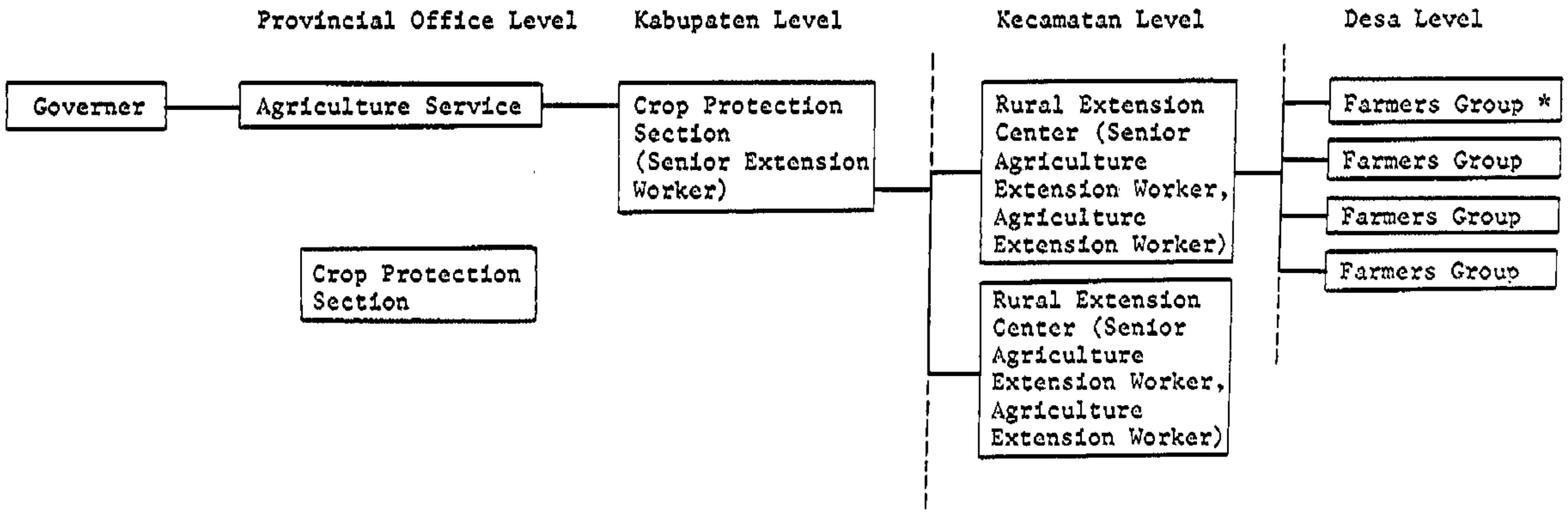
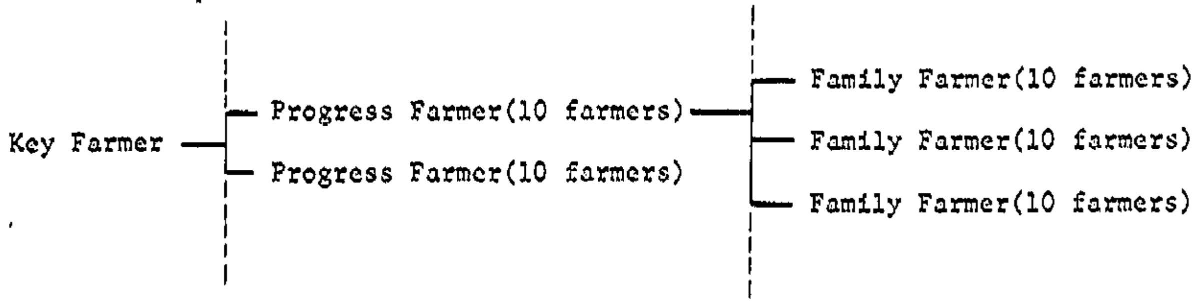
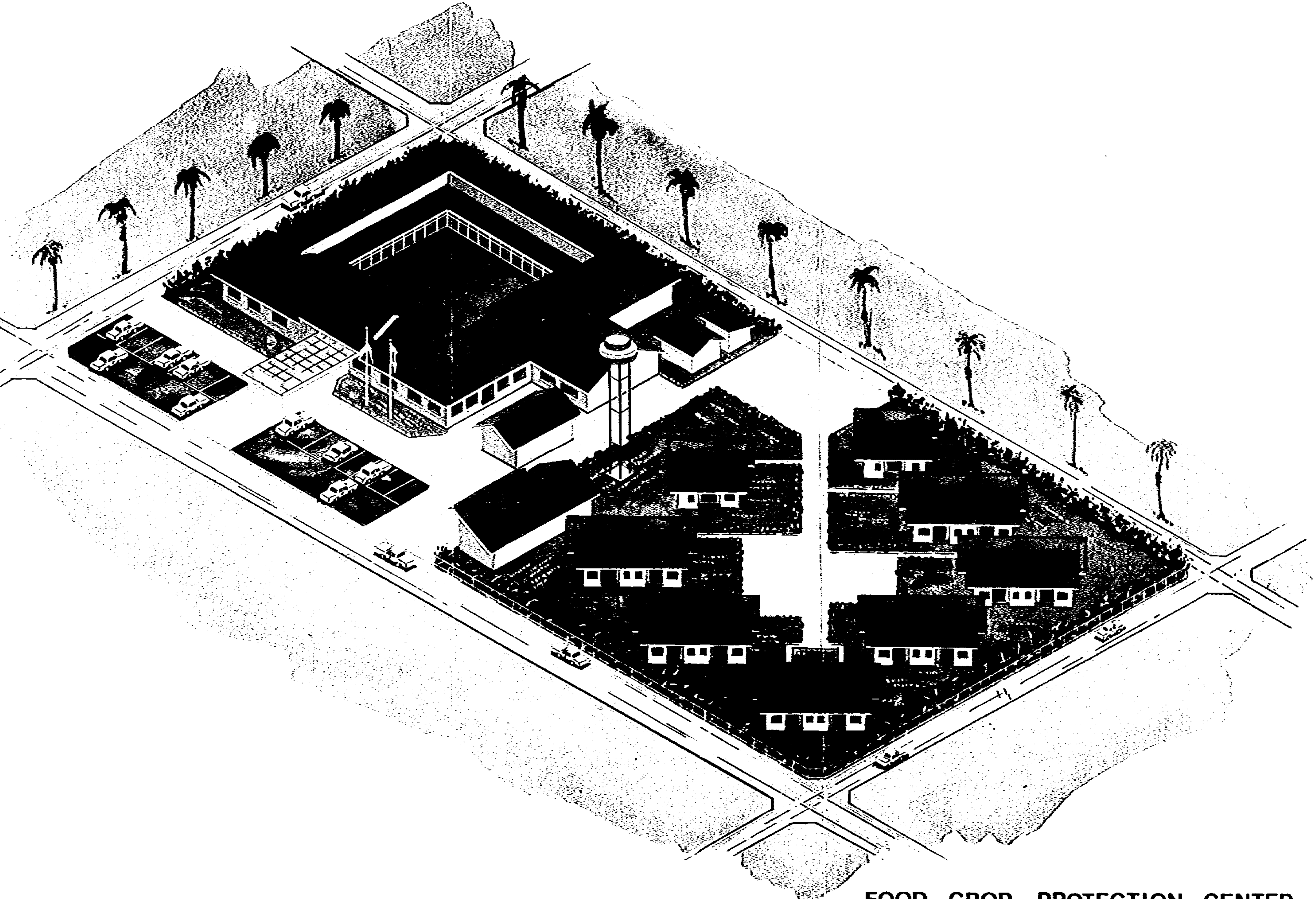


Fig. 25 Provincial Organizational Structure of Rice Protection



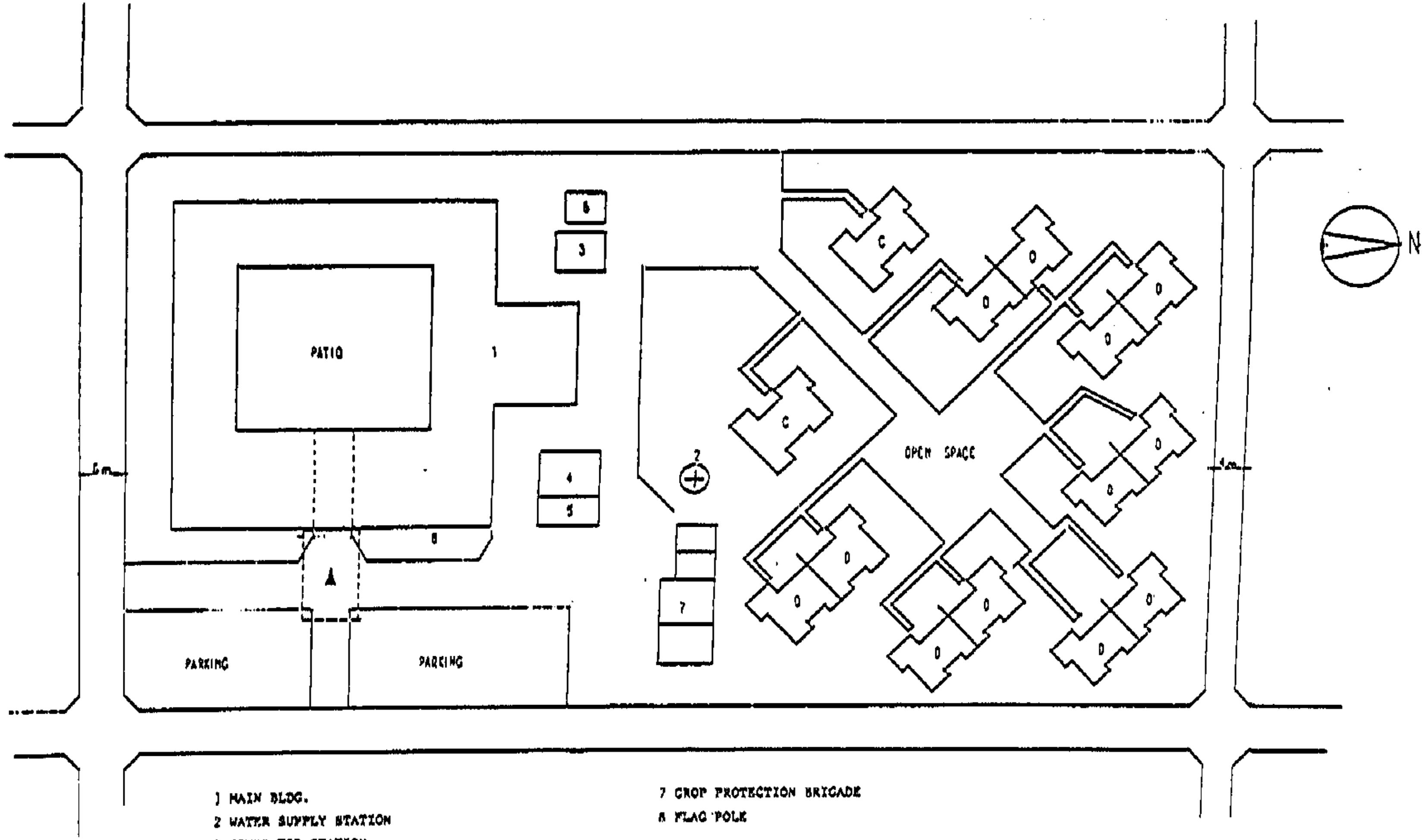
* Farmers Group Structure





FOOD CROP PROTECTION CENTER

Fig. 27 Block Plan of Food Crop Protection Center



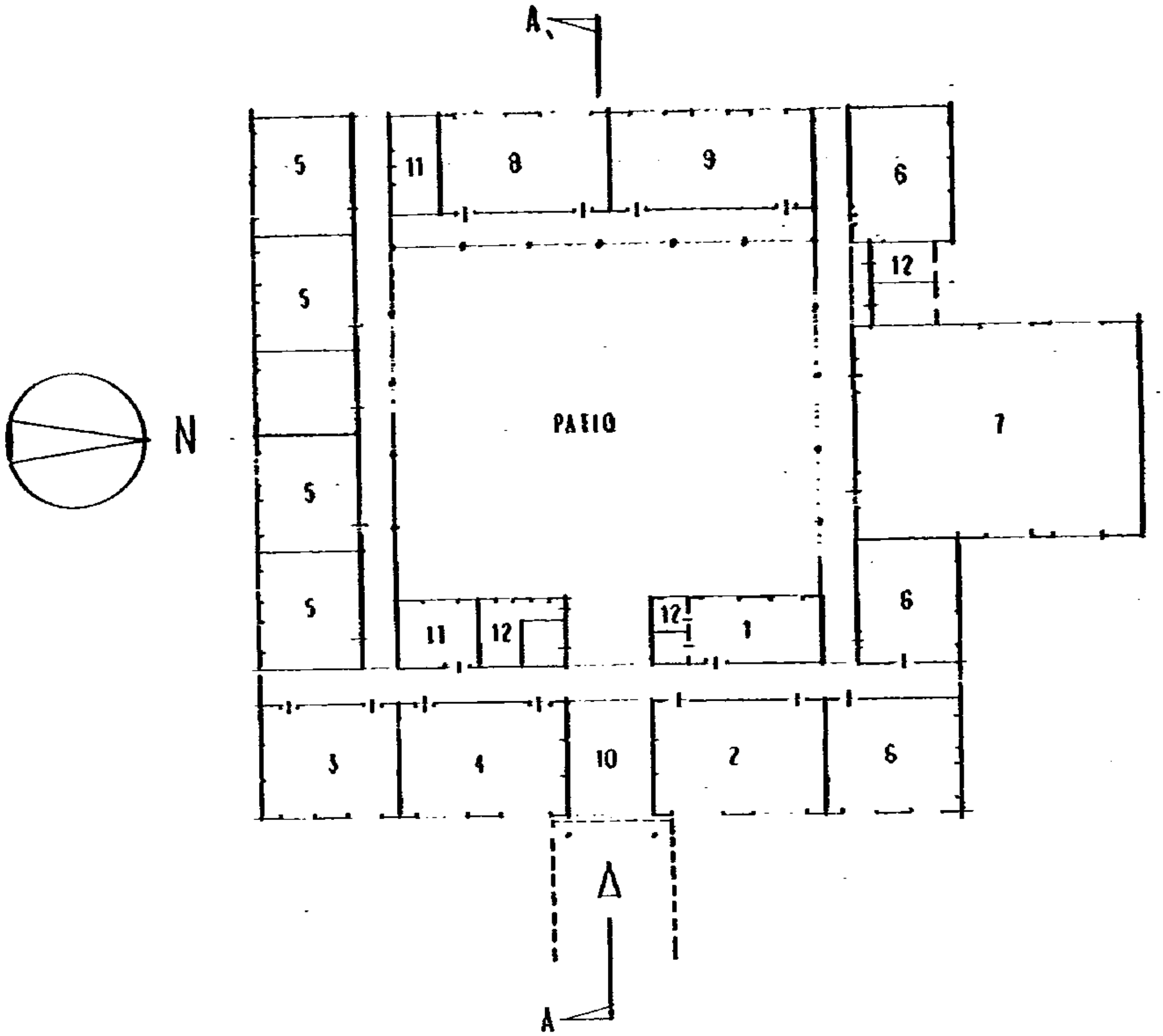
1 MAIN BLDG.
2 WATER SUPPLY STATION
3 GENERATOR STATION
4 STORAGE
5 PESTICIDES STORAGE
6 LABORATORY-WASTE TREATMENT FACILITIES

7 CROP PROTECTION BRIGADE
8 FLAG POLE

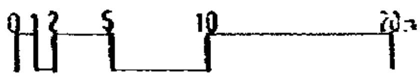
C STAFF HOUSE (V.I.P.)
D STAFF HOUSE

BLOCK PLAN OF FOOD CROP PROTECTION CENTERS SCALE 1/500

Fig. 28 Floor Plan of Food Crop Protection Center



1 DIRECTOR
2 ADMINISTRATION
3 STAFF ROOM
4 TECHNICAL STAFF ROOM
5 LABORATORY
6 PREPARATION ROOM
7 LARGE MEETING ROOM
8 SMALL MEETING ROOM
9 LIBRARY
10 HALL
11 STORAGE
12 LAVATORY



FOOD CROP PROTECTION CENTER

SCALE : 1/400

Fig. 29 General Drawings of Food Crop Protection Center

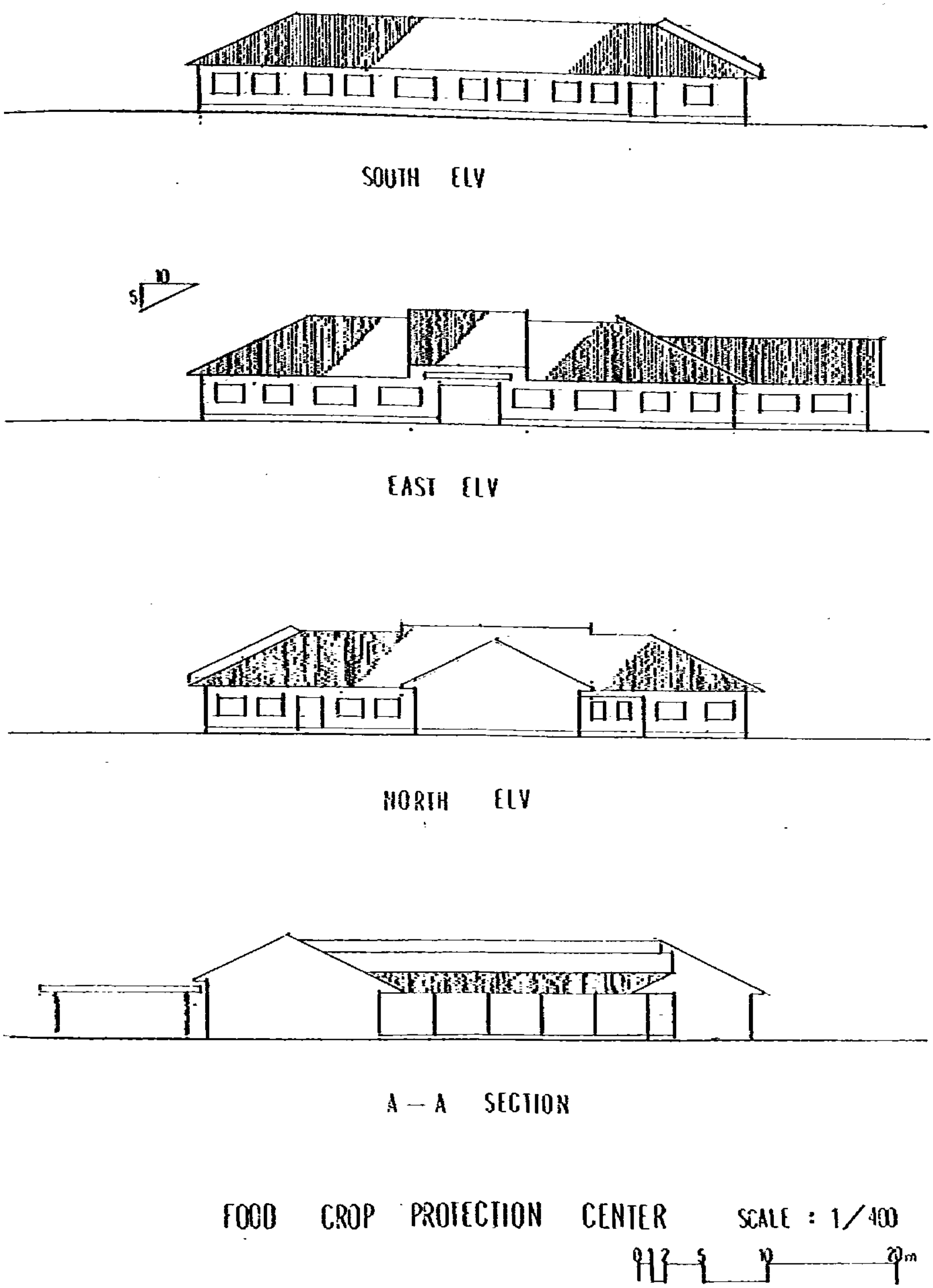


Fig. 30 Floor Plan and General Drawings of Crop Protection Brigade

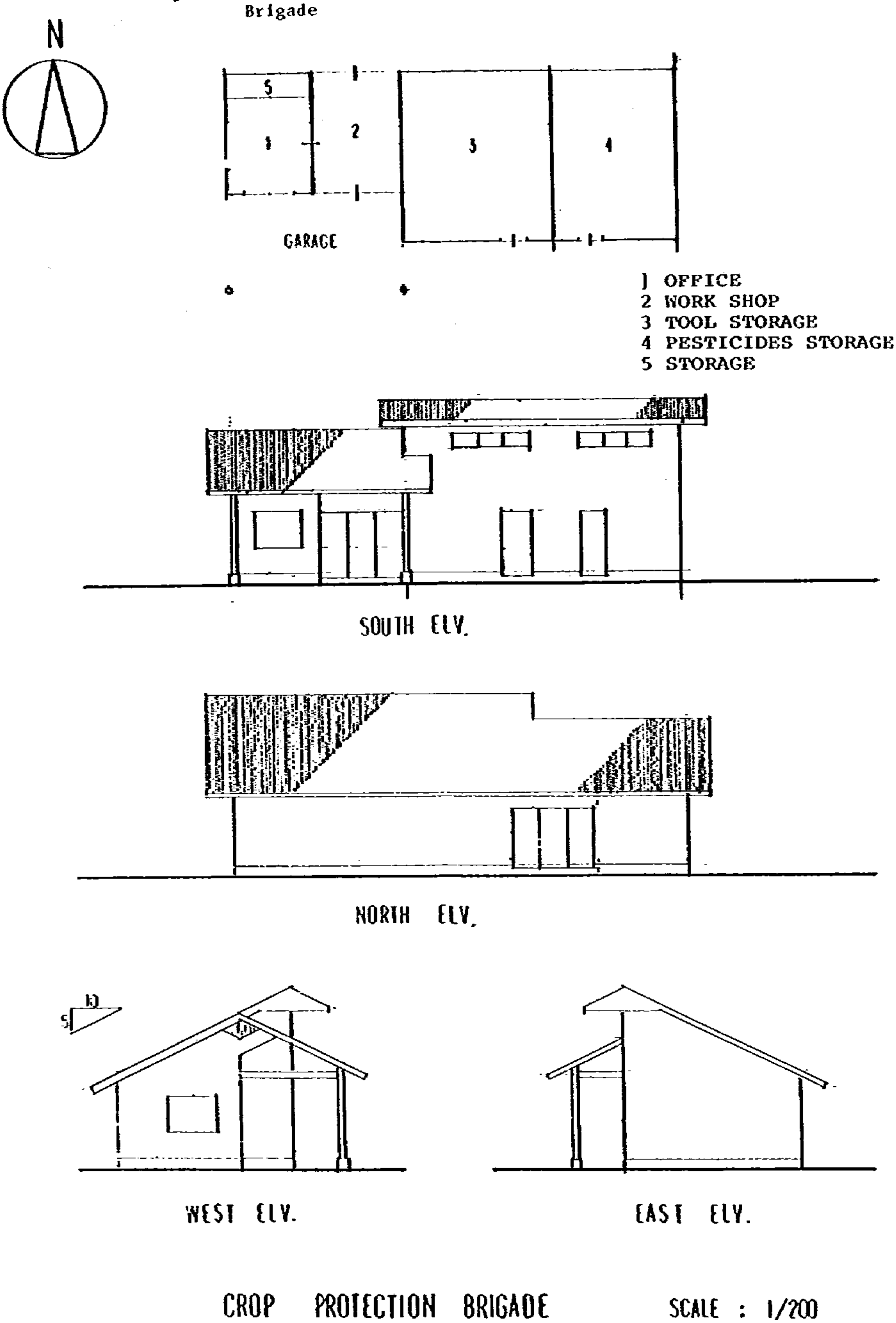


Fig. 31 Floor Plan and General Drawings of Staff House (Type C)

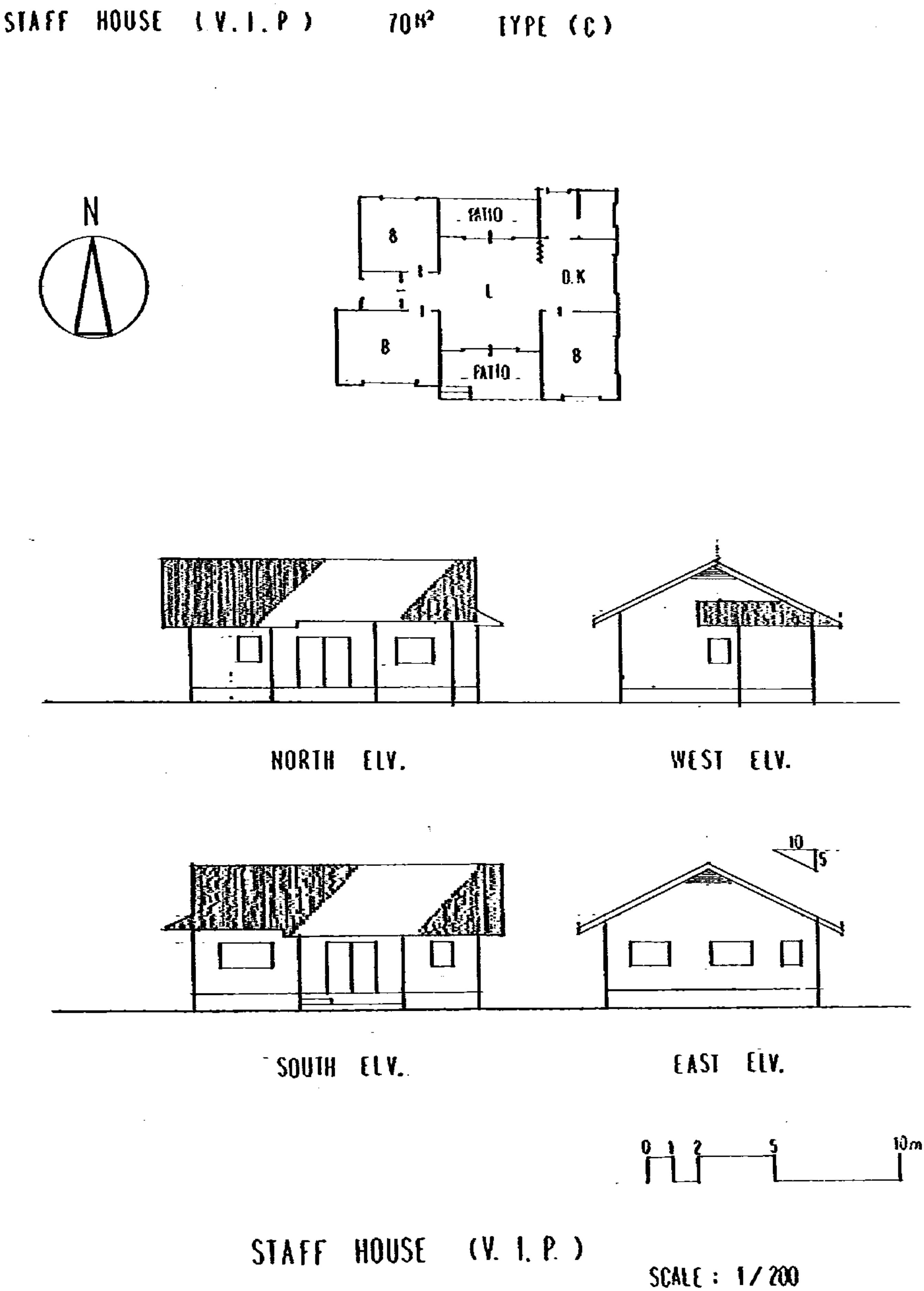
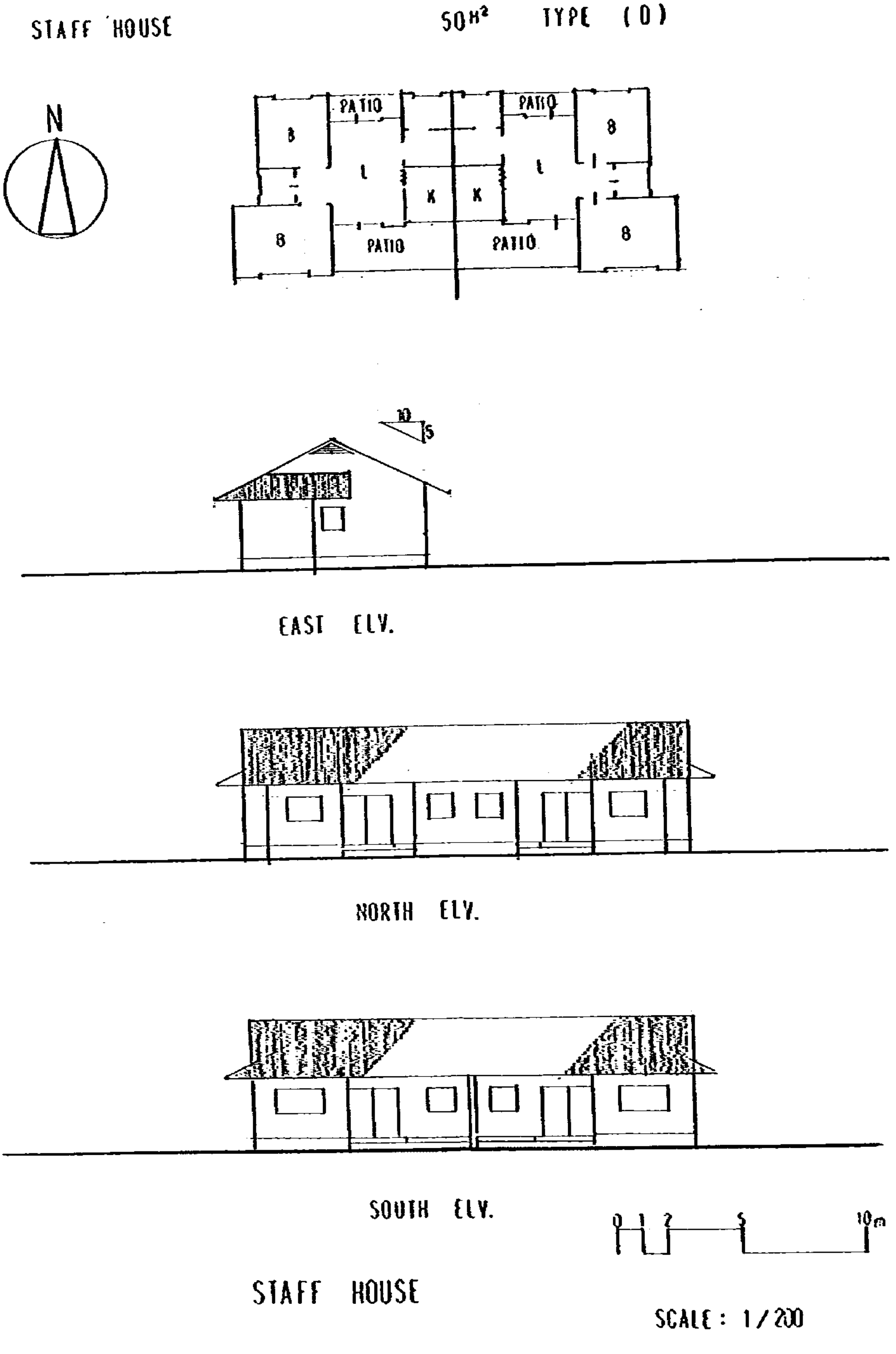
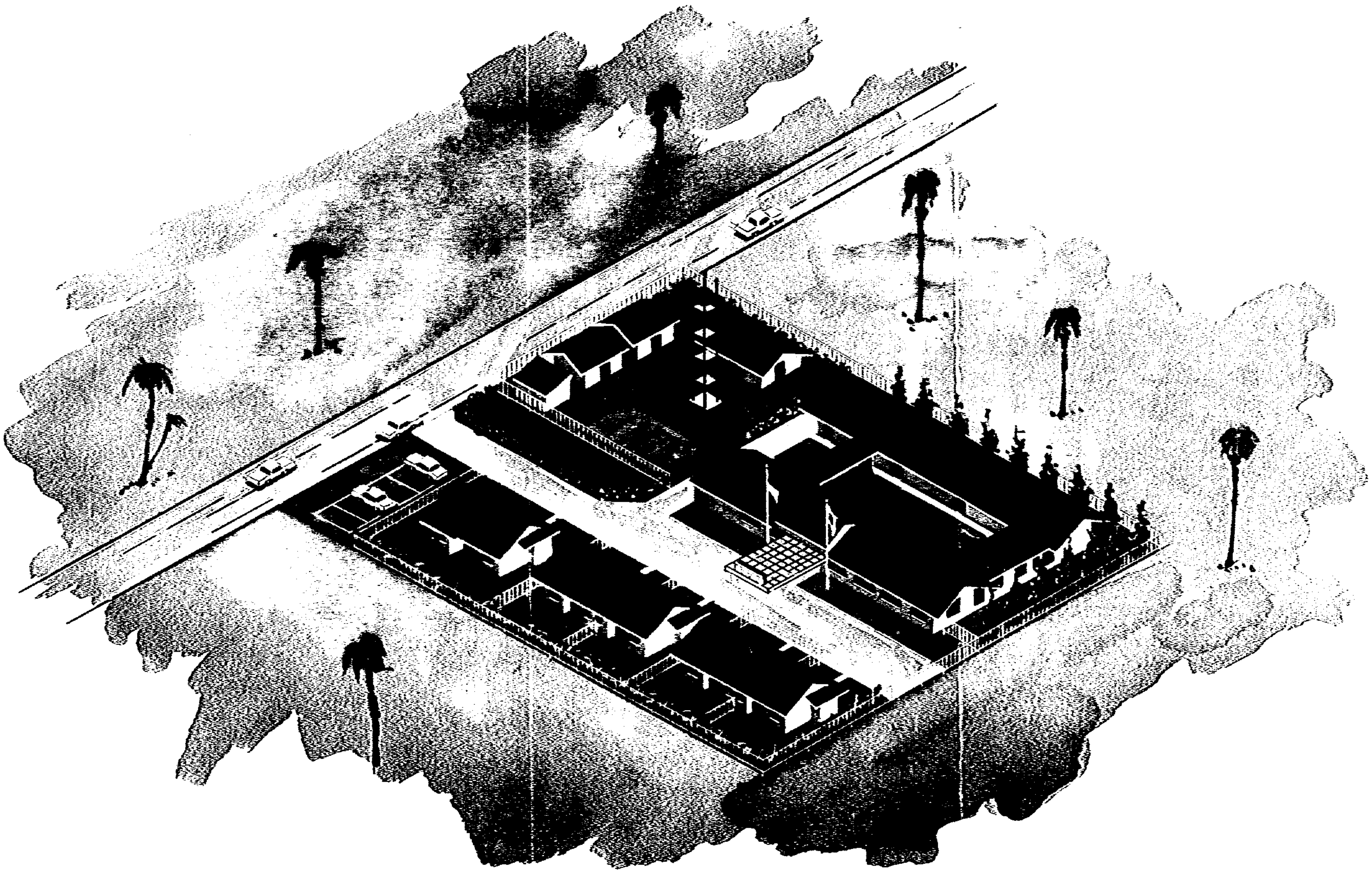


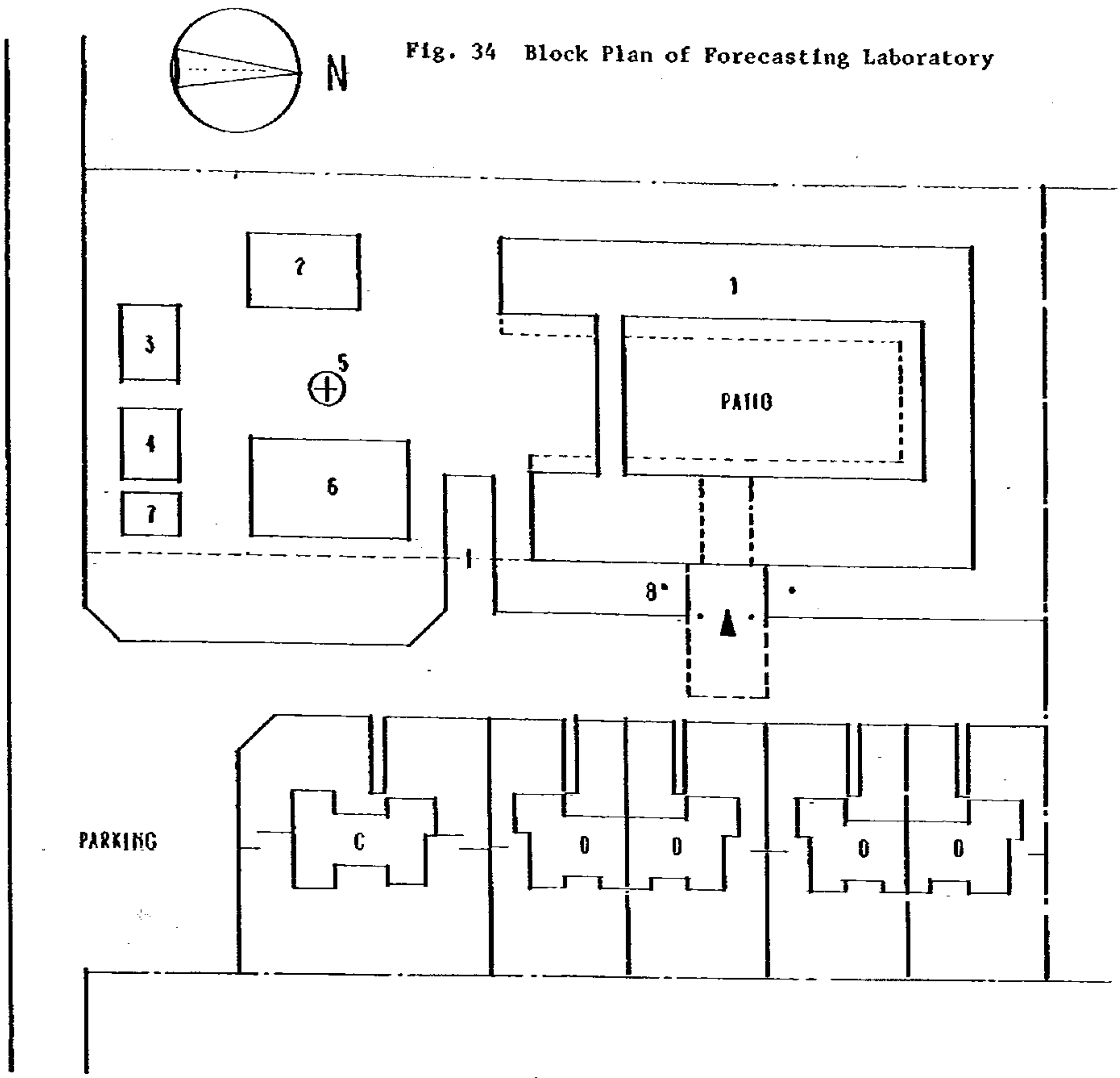
Fig. 32 Floor Plan and General Drawings of Staff House (Type D)





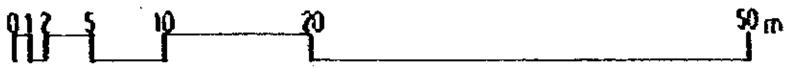
FORECASTING LABORATORY

Fig. 34 Block Plan of Forecasting Laboratory



1 MAIN BLDG.
2 GREEN HOUSE
3 PESTICIDES STORAGE
4 GENERATOR STATION
5 WATER SUPPLY STATION
6 OPEN AIR PADDY DRYING SPACE
7 LABORATORY WASTE TREATMENT FACILITIES
8 FLAG POLE

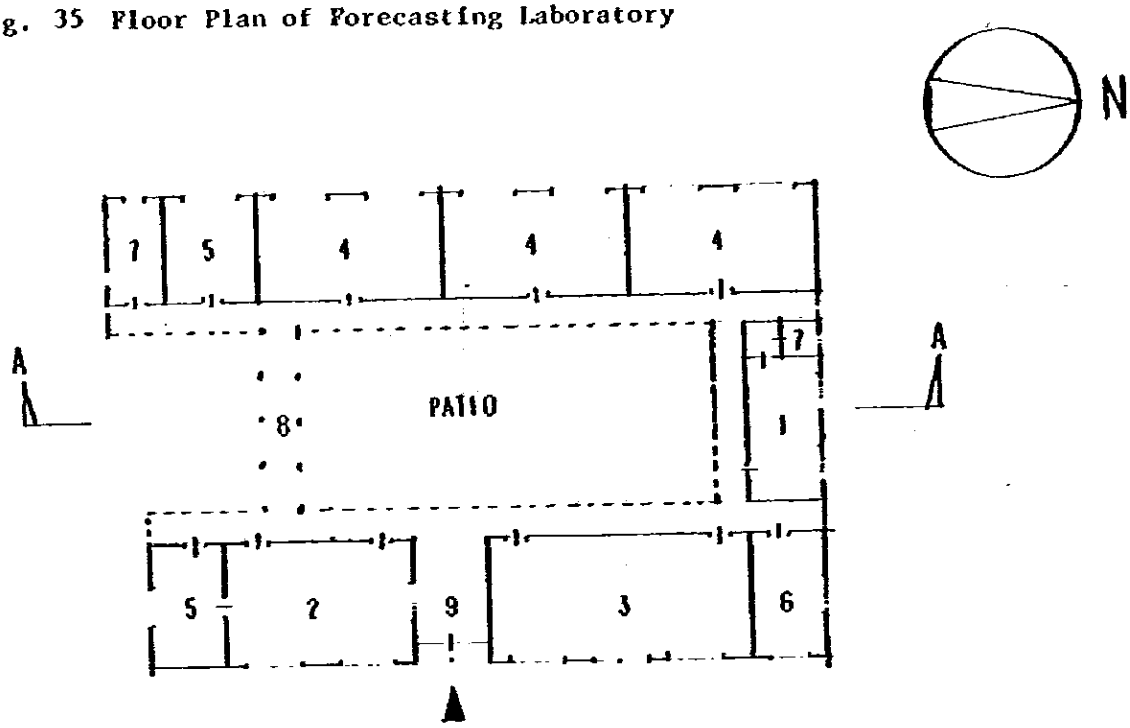
C STAFF HOUSE (V.I.P.)
D STAFF HOUSE



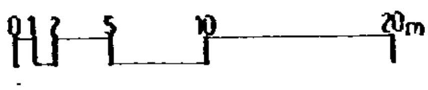
BLOCK PLAN OF FORECASTING LABORATORY AREA

SCALE : 1/500

Fig. 35 Floor Plan of Forecasting Laboratory

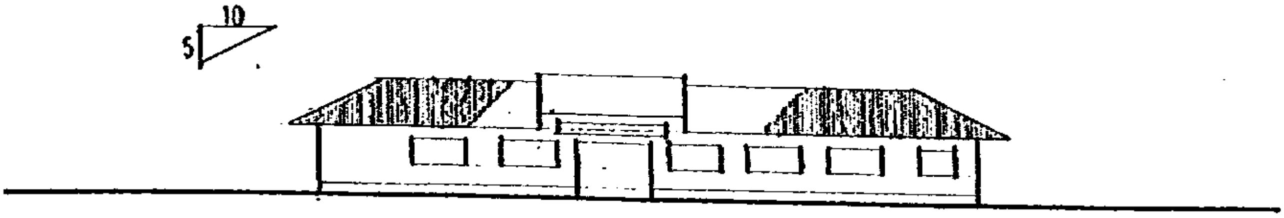


1 CHIEF
2 ADMINISTRATION
3 MEETING ROOM
4 LABORATORY
5 STORAGE
6 PREPARATION ROOM
7 LAVATORY
8 CORRIDOR
9 HALL

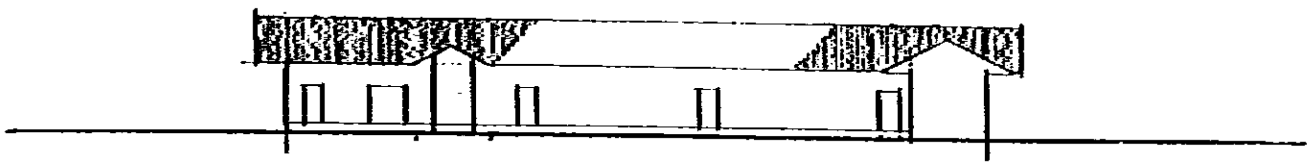


FORECASTING LABORATORY SCALE : 1/400

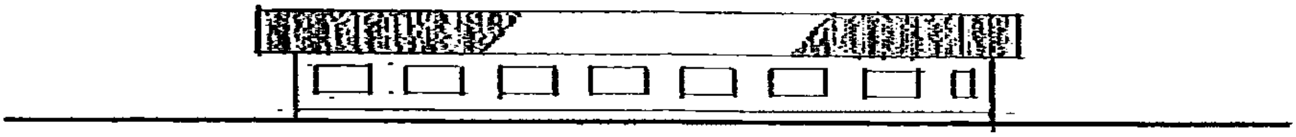
Fig. 36 General Drawings of Forecasting Laboratory



EAST ELAVATION



A-A SECTION



WEST ELEVATION

NORTH ELEVATION

FORECASTING LABORATORY SCALE : 1 / 400