INDONESIAN AGRICULTURE
ITS AGRICULTURAL ENGINEERING APPLICATIONS AND PROBLEMS

By

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A THESIS

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FOREWORD

Although the author has collected most of the information included herein and has made all the field observations during a two years' assignment as Agricultural Engineer with the United States Special Technical and Economic Mission to Indonesia, it must be clearly understood that all opinions, conclusions, and recommendations are those of the author alone. Any opinions, conclusions, or recommendations that are either expressed or implied must be attributed to the author; they cannot be interpreted to any degree whatsoever as representing the views or policies of the Government of the United States of America.

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The author wishes to express his sincere thanks to Mr. Ernest H. Kidder for his continued interest and valuable recommendations which have contributed to the completion of this work. He is also indebted to Mr. Arthur W. Farrall and to the Graduate Council of Michigan State College for their approval of this study which deviates far from that normal to the science of agricultural engineering.

The author sincerely appreciates the grant-in-aid of the General Education Board which enabled the completion of the resident study at Michigan State College that was preliminary to the study reported herein. He also wishes to express his appreciation to Louisiana State University for its approval of leave for the above resident study and the extension of this leave to permit the author to accept the two years' assignment in Indonesia. The author is also grateful to the various staff members of the Special and Technical Mission to Indonesia whose comments, suggestions, and encouragement have been most helpful.

The author is especially grateful to the many officials of the Ministry of Agriculture of the Republic of Indonesia for their assistance in furnishing reference materials with permission for their use and especially to Ingineur Kaslan A. Tohir, Chief of the Office of Foreign Agricultural Relations, and his assistant, Mr. Iman Sumadi, for reading and noting minor errors in Chapter XI, The Organization and Functions

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CHAPTER I

INTRODUCTION

A study of agriculture in general and agricultural engineering in particular in Indonesia is a study in contrasts with the small indigenous farmer at one extreme and the corporation type farming of the agricultural estates at the other. The small farmer seldom cultivates more than two acres and his investment in implements may be no more than the dollar that he has paid for his <u>changkol</u> or broad hoe bought without a handle while the area of the estates is measured in thousands of acres and the investment in field equipment alone may amount to several hundred thousand dollars. One North Sumatra corporation owned 33 Caterpillar tractors varying in size from the D-4 to the D-8 as a part of its field operating equipment in 1951. Another major contrast is the educational level; while the indigenous farmer usually is illiterate, an estate often is operated by a well trained staff which includes agricultural scientists, economists, processing and marketing specialists, and other technically trained support personnel such as mechanics and machinists.

The primary objective of the indigenous farmer is the production of sufficient food for himself and family, while the primary objective of the estate is the production and

processing of agricultural commodities for export, although the estates processing particular commodities supplement their own production by purchasing large quantities of raw products from the small farmers who produce the same commodity within economic hauling distances of the estates' processing plants. As will be shown in more detail later, the farmers' production of commodities for export has increased greatly during the Twentieth Century but rice remains the staple crop.

A number of factors have contributed to the lack of general advancement of Indonesian agricultural technology. Among the major pre-war factors was the paternalistic attitude of the Netherlands Indies Government towards the Indonesian people, an attitude the author had heard expressed in the statement that the people were happy with their conditions and customs and that it was a mistake to encourage them to change. Another facter was that of the subsistence type of farming and its accompanying barter economy, for under this economy the farmer was unable to purchase improved implements or other commodities necessary for improved techniques even if he had understood and wanted to utilize such techniques. Probably the factor of greatest importance to impede agricultural development, as well as development in other fields, has been the educational level of the population. Because of the high percentage of illiteracy any change from the traditional practices was

subject to suspicion and was accepted only after persuasion or even coercion as has been true in other parts of the world. In addition to the above factors there is the close relationship of traditional agricultural practices with the religious and social customs, a relationship which makes it difficult even for the few well educated people who desire to improve their conditions to utilize techniques which are at variance with traditional methods. Each of the above factors and relationships will be discussed more fully later.

In any listing of factors affecting agricultural development the demographic problem must be included. While Indonesia is not faced with the overall problem of "too many people - too little land" that has been used for other countries until it is a trite expression, the uneven distribution of its population makes the statement true for most of Java, Madura, and Bali and for a number of relatively small areas on some of the other islands. Transmigration or resettlement is underway but it is extremely doubtful if enough people can be moved from Java to reduce the population in view of the common estimate of 1.0 to 1.5 percent annual increase. As a means of developing the agricultural potential of the sparsely populated areas the movement of people is a worthwhile program but from the simplest estimates based on logistics it seems that those who at least publicly expect the population to remain at its present level or to be reduced are permitting themselves

to engage in wishful thinking.

The concept of agricultural engineering, as it has become accepted in North America, is new in Indonesia although there have necessarily been many applications of engineering in Indonesian agriculture. The major recognition of the science as such is in farm power and machinery just as was true in the United States when the first departments were established at Iowa State College and at the University of Nebraska in 1908. The greatest application of engineering principles in the indigenous agriculture has undoubtedly been in the field of irrigation but this is still considered to be primarily in the realm of civil engineering. From discussions with both Indonesian and Dutch personnel educated in the Dutch educational system it seems that agricultural scientists have little opportunity for specialization prior to study at the doctorate level and, although they are required to take more work in the basic engineering sciences of mathematics and physics than the American agricultural student, that there is no real opportunity for specialization in the applications of engineering in agriculture - these remain in the realm of the engineer who is called in more or less on a consultant basis but who was educated in an engineering college where little attention to the basic agricultural sciences was possible. The natural consequence of this has been that these scientists have become specialists in one of the other

fields in which they have been able to receive more training, the agriculturalists in other branches of agriculture and the engineers in other fields of engineering with few having the desirable minimum understanding of both the agricultural and the engineering aspects for optimum service to Indonesian agriculture where there were too few personnel available in either profession.

The objective of this study is to describe the agriculture of Indonesia in sufficient detail to permit the most important applications of engineering in Indonesian agriculture to be delineated. Reference will be made to such similarities as exist between conditions of Indonesian and American agriculture for the reference of those particularly interested in the tropical agriculture of these islands of the Far East. If agricultural engineering problems could be solved from the standpoint of the science alone, many of the problems would become relatively simple but when the cultural, social, economic, and political facets of the problems must be given due consideration, otherwise simple problems become complex. Because of the complexity of the general conditions in Indonesia Chapters II through VI are devoted to information that, in many respects, is far afield from agricultural engineering but without a reasonable understanding of which no foreigner can arrive at solutions of problems which may be technically and otherwise acceptable.

It should be stated that the material in these pages is by no means exhaustive; on the contrary it is very cursory for the presentation of the complete aspects of any particular phase of the diverse conditions of Indonesia would require the work of a lifetime and several volumes. Furthermore it has been necessary to limit most of the detailed descriptions, observations, and recommendations primarily to the agriculture of the small farmers because the nature of the author's work and travel in Indonesia has been directed at the solutions of the problems pertaining to general agriculture rather than the more specialized agriculture of the estates. Another limiting facter from the historical viewpoint is the limited agricultural literature available in English and Indonesian.

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CHAPTER II

GEOGRAPHY AND PEOPLE

The Republic of Indonesia extends over more than three thousand miles of land and sea from its northern extremity in Sumatra to the middle of New Guinea if the disputed territory of Irian is included. Its more than three thousand islands[1] have a total land area of 750,000 square miles, which is approximately equivalent to the area of the United States east of the Mississippi River. The island empire lies astride the equator, extending from six degrees north to eleven degrees south latitude. From west to east, it spans from ninety-six to one hundred forty-one degrees east longitude.

The major island groups are the Greater Sunda Islands, which include Sumatra, Java, Madura, Kalimantan, and Sulawesi; the Lesser Sunda Islands composed of Bali, Lombok, Sumbawa, Sumba, Flores, Timor, Suva, and Roti; and the Moluccas which extend northward from the Lesser Sundas almost to Mindanao in the Philippines and include Ternate, Tidore, Halmahera, Buru, Ceram, Amboina, and several smaller groups in the area between Ceram, Irian and Flores. Also included is the Riouw Archipelago, many small islands off the southern tip of the Malaya Peninsula, lying between

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1. Embassy of Indonesia, Inf. Div., Republic of Indonesia, The Country, The People, The History, Washington, 1951, p. 17.

Malaya and Sumatra.

Even casual inspection of the map (Fig. 1) shows the geographical importance of Indonesia. Traditionally its islands have been the stepping-stones for traders between Asia and Australia just as before the last glacial period it formed a land bridge between the continents[1]. Indonesia also occupies a dominating position in inter-ocean trade between the Pacific and Indian Oceans because all ships must travel within three hundred miles of Indonesian territory or sail south of Australia. In World War II the Japanese quickly occupied the area of Indonesia with little opposition and took full advantage of its strategic position to interfere with and destroy Allied shipping. If it had not been four thousand miles from Djakarta (Batavia) to Tokyo, the Japanese might have been able to use this area to a far greater advantage against the Allies.

For thousands of years the northern part of Sumatra has been the entry point into Indonesia for emigrants and traders from Asia and the Near East, who also were the missionaries for the religions of their areas. It is through this area that the migratory movement of the Proto-Malay people (Earlier-Malay) during the Neolithic Age spread over Indonesia about 3,000 B.C.[2]. Another migration by the Deutero-Malays (Later-Malays) during the Bronze Age 300-200 B.C.

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1. Bernard H. M. Vlekke, Nusantara, Harvard Univ. Press, Cambridge, Mass., 1945, p. xii.
2. Embassy of Indonesia, op, cit., pp. 73-79.

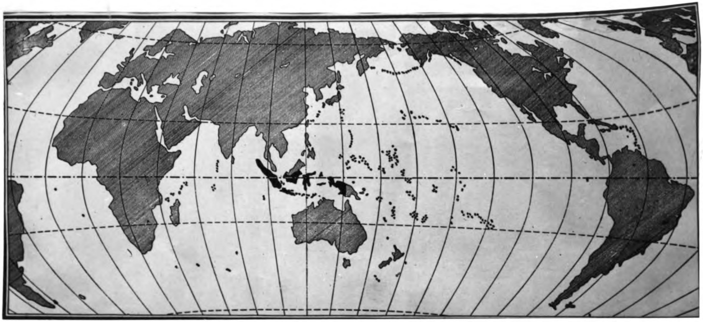

Figure 1. Map of the world showing location of Indonesia (Courtesy of Indonesian Embassy, Washington, D.C., and Ministry of Information, Djakarta)

is said by Kennedy[1] to have forced the Proto-Malays from the coastal areas to the higher island areas. The influence of the Mongoloid characteristics of the Deutero-Malays extended into Indonesia. Typically, the Indonesians from the island areas where the Proto-Malays were forced to move have darker complexions, are shorter and stockier in stature, and have wavier hair than the inhabitants of the coastal areas. In New Guinea the people are Papuan[2], a hybrid race originating from the Australoids and from the Melanesians who had migrated through Indonesia prior to the Neotholic Age. The Papuan people are characterized by their tall, thin, hairy bodies; angular, bearded faces; thin lips; long noses; and frizzly hair.

Vlekke[3] states that the Hindu influence entered Indonesia prior to the eighth century; however, other sources say that at the beginning of the historical era the Hindu influence began to appear from Indian traders and teachers. By the eleventh century most of the rulers of the Indonesian tribes and their courtiers had been converted to the Hindu faith. The Moslem religion entered in the same area of North Sumatra primarily through Arab traders and merchants, and the Hindu influence gradually shrank so that today it is of minor importance except on the island of Bali. The

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1. Raymond Kennedy, Islands and Peoples of the Indies, Smithsonian Inst. War Background Studies No. 14, Publication 3734, 1943, p. 5.
2. Ibid., p. 6.
3. Vlekke, op. cit., pp. 3-26.

Islamic faith continued spreading through the centuries until now it is variously estimated that from seventy to ninety percent of the Indonesians profess this religion, although the influence of ancient native customs modifies it to a considerable degree.

The Christian religion is the only religion to enter Indonesia by routes other than the North Sumatra one for two principal reasons. The Achinese people of North Sumatra were so strong in their following of Islamic teachings that they forcefully rejected any attempts of Christian missionaries to enter and were not completely under control of the Dutch until late in the nineteenth century. European traders of the sixteenth century who brought the first Christian missionaries to Indonesia were primarily interested in the spice trade which then centered in the Moluccas, where the Christian religion has been most readily accepted. As trade moved to other areas and the European population increased, the Christian religion was spread throughout the islands, but was never widely accepted. Vlekke[1] attributes the lack of acceptance, at least in part, to the lack of energy of the early Dutch priests who showed marked racial prejudice against native clergy. Over the course of the seventeenth and eighteenth centuries, the natives in the vicinity of Djakarta who did profess Christianity were absorbed into the Moslem religion in spite of the presence of twelve ministers

1. Ibid., p. 172.

of the Calvinist Church who were maintained by the Dutch East Indies Company in the city.

According to Kennedy[1] all religions, whether Christian, Mohammedan, or Hindu, are modified by the early culture and customs of the Indonesians. From the early pagan beliefs there remain influences of the ghost, spirit, and ancestor cults, as well as faith in magic. Inherent in the folklore are the fights between evil spirits or demons with legendary characters representing gods or historical leaders, struggles which in best folklore fashion end with the gods or historical leaders winning over the evil spirits. "Conversion" of the Indonesians to the Christian, Moslem, or Hindu religion has in many cases been primarily a changing of names for former customs and gods. The present general distribution of non-Moslem religions is Hinduism on the island of Bali and Christianity in the Batak highlands of Sumatra, in isolated villages in Kalimantan, in the Minehasa territory of North Sulawesi, on the island of Amboina in the Moluccas group, on the island of Flores in the Lesser Sunda islands, and among the non-Asiatic population throughout the Archipelago. The Moslem religion is embraced by the remainder of the population with the exception of a few small primitive tribes in remote islands and in remote areas that are still pagan or animistic.

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1. Kennedy, op. cit., p. 46.

The present day influence of the various religions upon Indonesian life is most apparent to the newcomer through the frequent official holidays and the black kupiah or fez worn by the men. While the latter probably was introduced along with the Moslem religion, it has been proclaimed the national headdress for men and is sometimes worn by men of other faiths upon formal occasions. The Indonesians recognize Christian religious holidays formerly observed by the Netherlands East Indies government as well as the Moslem holidays with the combination resulting in a total of twenty-two or twenty-three holidays per year. In addition to these recognized holidays the minority Chinese population observes the Chinese New Year, and a large percentage of the Chinese also observe the anniversary of the formation of the Communist regime of the New Chinese People's Republic. Chinese observance of these and other holidays virtually stops retail business in most cities and towns because most of the retail establishments and small industries are Chinese owned.

The Chinese population is estimated as between two and five million, but the Chinese predominance in trade and in the professions gives them far greater influence on the national economy than is proportionate to their numbers. Just as has been observed in other parts of the world, the Chinese people seemingly will not become assimilated into the population of their country of residence, but remain Chinese for several generations.

No census has been conducted since 1930, and present population estimates are usually calculated upon the 1930 figures plus an annual increase of one and one-half percent until 1940 and one percent after 1940 due to the effect of the war. The inequity of population distribution is shown in Table I based upon information from Kennedy[1] and from the Indonesian Ministry of Information[2].

The distribution of population is influenced by the natural factors of soil fertility and abundance of year-round streams. Wherever there is fertile soil and sufficient water to permit irrigation, the population density is greatest; wherever the soil is unproductive or there is insufficient water for irrigation, areas are sparsely populated. One of the sharpest contrasts is on the island of Bali where the one and one-quarter million population is largely concentrated in the central portion of the island's 2,300 square miles. All of the island is of volcanic origin, but in the central portion the annual rainfall is 3605 mm (142 in.) as compared with only 1671 mm (66 in.) in the western part of the island and only 1383 mm (55 in.) in the eastern part (Stations 60, 61, 62, Table III).

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1. Ibid., pp. 11-31.
2. Republic of Indonesia, op. cit., pp. 73-79.

TABLE I

POPULATION AND POPULATION DENSITY BY ISLANDS OR ISLAND GROUPS

Island or island group	Approximate area in sq. mi.	Population 1939 (1000's)	Population 1953 (1000's)	Population density per sq. mile, 1953
<u>Major islands or groups</u>				
Java and Madura	50,000	40,000.0	44,500.0	800.0
Sumatra	160,000	8,000.0	9,100.0	56.6
Kalimantan	290,000	2,500.0	2,690.0	9.3
Sulawesi	70,000	4,000.0[a]	4,000.0	57.2
Moluccas	35,000	425.0	483.0	13.8
Irian	150,000	1,000.0[a]	1,000.0	6.7
Lesser Sunda Islands	35,000	3,500.0	3,980.0	11.4
<u>Minor islands or groups</u>				
Bali	2,300	1,200.0	1,365.0	594.4
Lombok	2,000	700.0	795.0	39.3
Sumbawa	5,000	300.0	341.0	68.3
Sumba	5,500	100.0	113.8	20.7
Suva	200	30.0	34.1	17.0
Roti	650	60.0	68.2	10.5
Flores	5,600	500.0	570.0	10.2
Timor	9,600	700.0	796.0	8.9
Alor and Solor	2,000	150.0	171.0	8.6

a. In 1951 The Ministry of Information estimated the combined population of Sulawesi and West Irian at less than five million people.

TABLE I continued

Island or island group	Approximate area in sq. mi.	Population 1939 (1000's)	Population 1953 (1000's)	Population density per sq. mile, 1953
Minor islands or groups continued				
Wetar	1,200	7.5	8.5	7.1
Kisar	50	9.0	10.2	202.0
Leti Islands	350	1.5	17.1	48.8
Luang Islands	150	5.0	5.7	37.9
Roma Islands	200	3.0	3.4	17.0
Nila Islands	100	3.0	3.4	34.0
Tanimbar (66 islands, 7 inhabited)	2,150	25.0	28.4	13.2
Kai Islands	575	30.0	34.2	60.0
Aru Islands (over 100 islands)	3,350	20.0	22.8	6.8
Watubela Islands (6 islands)	150	2.5	2.8	18.7
Goram Islands (6 islands)	200	6.0	6.8	34.0
Ceram Laut (12 islands)	100	6.0	6.8	68.0
Banda (11 islands)	100	6.0	6.8	68.0
Amboina	500	60.0	68.2	136.2
Ceram	6,700	60.0	68.2	10.1
Buru	3,400	20.0	22.8	6.7
Sula Islands	5,000	15.0	17.1	3.4
Halmahera	6,500	50.0	56.9	53.7
Ternate	25	10.0	11.3	452.0
Tidore	25	15.0	17.1	685.0
Makian (3 islands)	50	10.0	11.3	226.5

TABLE I Continued

Island or island group	Approximate area in sq. mi.	Population 1939 (1000's)	Population 1953 (1000's)	Population density per sq. mile, 1953
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TABLE I Continued

Island or island group	Approximate area in sq. mi.	Population 1939 (1000's)	Population 1953 (1000's)	Population density per sq. mile, 1953
Minor islands or groups continued				
Batjan (3 islands)	1,000	10.0	11.3	11.3
Obi	1,000	2.0	2.3	2.3

CHAPTER III

HISTORY OF INDEPENDENCE AND FORM OF GOVERNMENT

Indonesia is the youngest sovereign nation of the world, having gained *de jure* recognition on December 27, 1949,[1] after more than four years of revolution and negotiations with the Dutch. On August 17, 1945, President Sukarno issued the Indonesian Declaration of Independence only two days after the capitulation of the Japanese[2]. For the first time in three hundred and fifty years all of the people became a single, free nation. Independence was not yet complete, but when the British landed with a token force six weeks later, they found a government functioning which represented *de facto* authority in Sumatra, Java, and Madura and which claimed *de jure* authority for all of the former Netherlands East Indies territory.

The token British force landed about October 1, 1945, to accept the surrender of the Japanese occupation troops and to liberate prisoners of war in the name of the Allies. Soon thereafter the officials of the Netherlands Indies Government returned to Indonesia from Australia where they had fled in 1942 when the Japanese occupied Indonesia. Actually, in several instances the Japanese had already

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1. Ibid., p. 1.
2. Ibid., p. 35.

surrendered and turned over their arms and ammunition to the *de facto* Indonesian Government, and while the official surrender was made to the small British force present, the Indonesians were able to obtain more of the Japanese arms, munitions, and equipment with which to fight in the four years of "police actions" and revolutions which were to follow. In these struggles another advantage for the Indonesians was the military training received from the Japanese during the late stages of the war. Units of the People's Army (*Laskar Rakjat*) were equipped with small arms and trained by the Japanese in the expectation that the Indonesians would fight with them as allies.

The political negotiations, from September 1945 to January 1948, have been described in detail and the military or police actions to a lesser degree by Wolf[1]. In 1945, after the surrender of Japanese troops to the British, the troops of the Netherlands returned. The Indonesians did not agree for these troops to land before their independence was recognized, and when the attempts at landing were made, fighting began on a large scale.

The British arranged a truce under the good offices of Lord Killearn, England's Special Commissioner. The Linggadjati Agreement, signed on November 15, 1946, between the Government of the Netherlands and the Republic of Indonesia,

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1. Charles Wolf, Jr., *The Indonesian Story*, John Day and Co., New York, 1948, passim, pp. 1-191.

recognized the sovereignty of the Republic over Java and Sumatra, but left intact the bridgeheads held by Dutch troops in the areas of the principal cities of these two islands. Both governments pledged themselves to the early formation of the United States of Indonesia, which would be encompassed within a commonwealth, along with the Netherlands, Surinam, and Curacao, not later than January, 1949. The United States of Indonesia was to include the Republic of Indonesia, Kalimantan (South Borneo), and the Great Eastern State (composed of Sulawesi [Celebes]. the Moluccas, and the Lesser Sunda Islands).

The ensuing months resulted in many violations of the truce by both sides, and on July 18, 1947, the Dutch initiated a "police action" to restore "order". At that time the Dutch forces were estimated at one hundred and nine thousand well-equipped men, while the Indonesian forces were relatively poorly equipped and trained. The Dutch forces[1] were able to penetrate the republican territory almost at will but were unable to destroy the estimated two hundred thousand Indonesian troops who, unable to undertake pitched battle or to contain the Dutch within the bridgeheads, adopted guerrilla tactics and began a battle of attrition.

The situation was brought before the Security Council of the United Nations, which entered the negotiations by

1. Ibid., p. 132.

first issuing a cease-fire order in August 1947. Through the Good Offices Committee of the Security Council, a cease-fire agreement was arranged along the status quo lines of August 27, 1947[1], and on January 17, 1948, a second agreement known as the Renville Agreement was signed. At the request of Frank Graham, United States representative on the Security Council Good Offices Committee, the United States of America sent the U.S.S. Renville to anchor off Djakarta for the consummation of this agreement, this measure becoming necessary when representatives of neither side would agree to meet in the territory held by the opposite forces[2].

Further negotiations were unsuccessful, and on December 18, 1948, the Dutch forces initiated a second "police action", capturing President Sukarno, Vice-President Hatta, and a number of ministers of the Republic[3]. This action was termed a direct violation of the principles of the United Nations Charter and of the Renville Agreement by the Good Offices Committee. A nineteen-nation Asian conference headed by Prime Minister Nehru of India demanded that the Dutch surrender all prisoners and territory and grant full sovereignty for Indonesia. The United Nations recommended the establishment of a time-table for the

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1. Embassy of Indonesia, op. cit., p. 37.
2. Wolf, Jr., op. cit., p. 147.
3. Embassy of Indonesia, op. cit., p. 38.

gradual transfer of sovereignty by July 1, 1950.

The Round Table Conference convened at the Hague on August 23, 1949. After further negotiations a proclamation was issued on December 27, 1949, transferring sovereignty from the Netherlands government to that of the United States of Indonesia. The Netherlands Indonesian Union was established simultaneously as a voluntary union between sovereign states to facilitate foreign relations, defense, economics, and commerce.

The United States of Indonesia, to which sovereignty was transferred at the Round Table Conference, was a federation of sixteen autonomous states, the strongest of which was the Republic of Indonesia. Within less than a year the other fifteen states, through action of their own legislative councils, dissolved their respective governments and merged with the Republic of Indonesia to form a new unitary state under a revised constitution. On August 17, 1950, exactly five years after the original proclamation of independence, President Sukarno issued another proclamation establishing the new government. The provisional constitution was drafted by the representative bodies of all the states of Indonesia and was based upon the constitution of the former Republic, which in turn had been modeled after the Constitution of the United States of America.

Under provisions of the Constitution, the first president and the first vice-president were elected by the

unicameral Parliament for four years. The President is empowered to dissolve Parliament, to introduce and approve legislation, and to appoint the formateur or formateurs of the cabinet who act according to the mandate given by the President at the time of his appointment. The two hundred and thirty-seven members of Parliament were initially appointed by the legislative bodies of the former sixteen states, with one member per three hundred thousand population, to represent all political parties, social groups, and geographical areas. Subsequent executives and members of Parliament will be elected at four year intervals.

The Cabinet is a coalition, representing enough of the many political parties and groups to obtain parliamentary support. It may be dissolved either by action of the President or by a vote of no-confidence on the part of Parliament. Because representation in Parliament is in proportion to the strength of the various political parties, any action of the Cabinet must have the support of the strongest parties, or it is faced with plenary session debates in Parliament and the problem of successfully defending its action against a motion of no-confidence. Even if the defense is successful, the party opposing the action may withdraw its ministers from the Cabinet and thus break down the coalition. At least until general elections can be held for the election of executives and members of Parliament by the people under definite programs or platforms,

the position of cabinets will probably remain precarious. Consolidation of several of the parties would undoubtedly improve the stability of the cabinets, but seems unlikely because of differences in religions and political ideologies and political ambitions of party leaders.

The size of the cabinet, as well as the number of ministers, has varied in several cabinets; there have been ministers without portfolio, perhaps as the only means of obtaining support of enough political parties to enable formation of a cabinet under specific conditions. The April 1952 - June 1953 cabinet consisted of the Prime Minister, the Vice-Prime Minister and sixteen ministers with portfolios that are listed below in their order of precedence. This cabinet resigned June 3, 1953 with the statement that it was returning its mandate because insufficient support from the political parties representatives in Parliament had made it impossible for the cabinet to be effective.

1. Foreign Affairs
2. Interior Affairs
3. Defense
4. Justice
5. Information
6. Finance
7. Agriculture
8. Economic Affairs
9. Communications
10. Public Works
11. Labor
12. Social Affairs
13. Education
14. Religious Affairs
15. Health
16. Personnel Affairs[1]

1. In May 1953, upon the resignation of the Minister of Social Affairs, the Minister of Personnel Affairs was given the Social Affairs portfolio which was enlarged to include the Ministry of Personnel Affairs.

The Cabinet formulates the general program of the government, while each ministry prepares the operation plans pertinent to its area of responsibility. Actual operations are the responsibility of the divisions or services of the ministries which have direct contact with the people through their representatives at the provincial, district and sub-district levels. The governors and other administrative officials for the ten provinces and the special area of Djogjakarta, as well as for several autonomous areas or municipalities, are appointed by the Ministry of Interior Affairs, a procedure which will be continued until general elections can be conducted. Similarly, the divisions or services of the ministries appoint the officials necessary to perform their various functions at provincial and lower levels.

At this time there is virtually no autonomous authority at the provincial and lower levels because all resources are under control of the central government. Almost all revenues result from taxes levied by the central government and all expenditures are in accordance with the central government's budget which allocates funds to the ministries and from which specific service or division allocations are made to the provinces based upon compromise between local needs and funds available. Kalimantan was made an autonomous province by government decree in January 1953, but the extent of its authority was not defined at the time of the decree.

In theory the budgets are subject to parliamentary approval, but in fact they are made by the Cabinet because Parliament has remained one to two years behind in its budgetry debates. The 1953 budget presented to Parliament in December 1952, by Finance Minister Sumitro was the first budget to be submitted for prier approval.

The government's principal sources of revenue are export and import duties, export of tin from government owned mines, and income taxes. The financial status of the government reflects very quickly the condition of the world markets in tea, tobacco, petroleum, palm oil, rubber, and copra because these commodities make up a large percentage of the value of export commodities. This group of exports represented 80 percent in 1950 and 85 percent in 1951 of the total value of Indonesian exports[1]. Rubber alone accounted for 56 percent of the value of exports in 1950, but with the increase in total value of all exports of slightly over 50 percent in 1951 it represented only 35 percent. Kapok, pepper, peanuts, and corn were the only four of 32 items listed showing a decrease in export value. The decrease of the latter two occurred primarily because of restrictions on export of foods in order to reduce the over-all shortage of food in the country. Under

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1. Ministries of Economic Affairs and Agriculture, Warta Ekonomi, Ekspor Dari Indonesia Dalam Tahun 1951-1952, Tahun Ke-5, No. 11, 1952, Dhakarta, Indonesia, p. 193.

favorable market conditions and import restrictions in 1951, the treasury showed a net gain, but with the decline in the price of rubber early in 1952, the estimated deficit for 1952 is placed between four and six billion rupiah (11.4 rupiah = 1 dollar).

The 1945 Republic of Indonesia included only Java and Sumatra which became one of the sixteen states of the United States of Indonesia following the transfer of sovereignty in 1949. The present Republic of Indonesia is divided into provinces (states), kabupatens (districts or residencies), and wedanos or daerahs (sub-districts). The number of districts and sub-districts varies in the different provinces in proportion to the density of population and to some extent, according to the administrative difficulties caused by inadequate communications. Provinces with their capitals are listed below:

North Sumatra - Medan
Central Sumatra - Bukit Tinggi (Fort de Kock)
South Sumatra - Palembang
West Java - Bandung
Central Java - Semarang
East Java and Madura - Surabaja, Java
Kalimantan - Bandjermasin
Sulawesi - Makassar
Moluccas - Ambon, Amboina
Lesser Sunda Islands - Singinradjah, Bali

CHAPTER IV

PRESENT POLITICAL AND SECURITY SITUATION

It is impossible for any program for the improvement of agriculture or for any other portions of the Indonesian economy to be considered without giving attention to the political reaction throughout Indonesia and the security situation in the particular area concerned in the implementation of specific projects. As might be expected from any nation recently freed of occupation by foreign armies and freed of colonial domination, there is an intense nationalistic feeling; indeed had it not been for such feeling, independence would have come much more slowly. Also, as might be expected in any country that has been subjected to more than seven years of occupation and revolution, lawless elements exist because of a desire to overthrow the government, because of religious fanaticism, because of desire for revenge against individuals, corporations, or nationalities for real or imaginary mistreatment, because of economic conditions, and because of the ease of robbery and pillage in comparison to the effort required to work for a living. All of these elements are present in Indonesia in one or more locations and vary in degree of seriousness and effect upon the development of the nation's vast resources of people, land, and minerals.

The Round Table Conference agreement did not include a settlement of the control of Irian (western New Guinea).

According to Goldberg[1] the Indonesians reluctantly agreed at the conference to continuation of the status quo for Irian, i.e., temporary control by the Netherlands, in order to attain agreement upon the more fundamental issues involved in the transfer of sovereignty. It was, however, agreed that negotiations would be reopened immediately following the closing of the conference with the objective of reaching a solution within a year. Because Irian was a part of the former Netherlands East Indies, the Indonesians have continuously maintained that it should be included in the territory of the Republic of Indonesia. While the primary desire of Indonesia for Irian is to completely eliminate all vestige of colonialism and Dutch sovereignty from the area, there also exists a secondary reason -- the possible use of Irian by the Dutch to regain control of the Archipelago.

In the opinion of some Indonesians one of the underlying reasons for the dissolution of the United States of Indonesia was to eliminate the existence of governments in some of the states which were established by the Dutch during the post-war period and which, if not actually subservient to the Dutch, were indebted to them for their power. When the unitary state was formed, a dissenting group proclaimed the Republic of the South Moluccas to be sovereign

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1. Harry Goldberg, Foreign Observers on the Question of West Irian, Ministry of Information, Republic of Indonesia, Djakarta, undated, released 1952, p. 2.

and independent in spite of the expressed desire of its former representatives to participate in the new state. This dissenting group has opposed the government's efforts to establish law and order and as late as the summer of 1952 was of sufficient size that several battalions of the Indonesian Army were fighting against the Republic of South Moluccas on the eastern half of the island of Ceram. This operation of the Army was declared complete and most of the troops moved to South Sulawesi in the fall of 1952. With the proximity of Ceram to Irian, some Indonesians believe that the forces of the Republic of South Moluccas received assistance from Irian. This belief is supported at least in part by the statement of a Dutch national in Djakarta to the author that contributions are being made by private individuals in Holland for the Republic of South Moluccas. He also stated that there are Dutch citizens who expect to regain control of Indonesia when its government fails, but in this man's opinion the possibility of the Netherlands regaining control of Indonesia is wishful thinking.

The Netherlands Parliament early in 1952 added fuel to the nationalistic fires of Indonesia by unilaterally declaring Irian to be a part of the Dutch Union while Indonesian representatives were in The Hague, presumably negotiating the matter at the conference table. The more out-spoken elements of the political parties have advocated abrogation of the Netherlands-Indonesian Union, unilaterally

if necessary, and Indonesian assumption of control in Irian, suggesting force if necessary. Discharge of all Dutch employees of the Indonesian government and expropriation of Dutch property were also mentioned in the press. However, the more conservative and realistic leaders, including those active in the government and those outside, have been able to restrain such actions with their counsel of first exhausting all possible peaceful means. Indonesians of all stations in society, of all religious faiths, and of all political parties are agreed, however, that eventually Irian should become a part of the Indonesian Republic.

The Dutch position concerning Irian is that the Papuan people who are the natives of Irian have nothing in common with the Indonesian people and that due to lack of education they are not qualified at this time to decide what type of government they should have, but that after sufficient time to permit education, the people will be allowed to decide by plebiscite what form of government they desire. The Dutch further contend that Irian cannot be developed by the Republic of Indonesia because of the dearth of capital and technically qualified personnel, especially since the Indonesians must expend their greatest effort nearer their center of population in Java and Madura.

From the standpoint of pure logic the Dutch contentions cannot be refuted since the Papuan people of Irian are a hybrid race[1] originating from Melanesian and Australoid

1. Kennedy, op. cit., p. 6.

ancestors, while other Indonesians are primarily of Malayan origin. Irian occupies approximately one-half of the world's second largest and least developed island, and its population is said to be the world's most primitive people. Irian is far removed from Indonesia's population center. From the standpoint of available, qualified technical personnel, certainly the Dutch are by far better qualified at this time, but these questions may well be raised: For whose benefit will development be undertaken? How long before a plebiscite can be held?

It is apparent that development of the 150,000 square miles of Irian's territory will progress slowly until the political discussions are concluded. Even without the political complications, the basic facts of logistics indicate slow progress as does previous experience of the Dutch in the East Indies. In almost three hundred and fifty years there was little development attributable to the Dutch except on the islands of Sumatra, Java, and Madura and in a few coastal areas of some other islands. With improved transportation, progress should be possible at an accelerated rate, but adequate transportation is still non-existent in Indonesia and will be the subject of a later section. An early or easy solution of the Irian question does not appear likely. It will be extremely difficult, if at all possible, to obtain agreement between the dogmatic logic on one side of the conference table and

the fervor of nationalism on the other. The action of the Dutch government in October 1952, declaring they could see no reason for reopening negotiations on this question, confirms this opinion.

In contrast to the Irian question, no voice has been heard in Indonesia relative to Australian control of the eastern half of New Guinea, although recent indications that Australia favors Dutch control of Irian have met strong opposition in the Indonesian press. Furthermore, no question has been raised in regard to the 450 mile international jungle boundary between Irian and Australian New Guinea. Similarly, there is no problem about Portugese control of East Timor, whose 4500 square miles is hardly more than a trading post, nor of British control of Serawak and Brunei in British North Borneo, presumably because none of these was a part of the Netherlands East Indies.

South Sulawesi is another problem area for the Indonesian government because of activities of guerrilla bands. In the general vicinity of Makassar numerous bands are active burning villages, murdering, robbing, and kidnapping. Many farmers have moved to the towns and cities in search of safety, thus lowering agricultural production and increasing the unemployment situation in the cities with its resultant increase in petty thievery and pilferage. In July 1952, two men were kidnapped on the highway between the Makassar airport and the city, about fifteen miles away.

On another road about ten miles from Makassar a police informer was murdered. Such incidents were and still are quite common, and the Army and National Police have not yet been able to restore order. Before travel from one city to another is possible, one must have passes, and police inspection points for automobiles and personnel are located between most of the towns in an effort to control movement of weapons and stolen goods. Pilferage of rice passing through the Makassar port in June 1952, was estimated at 25 percent by the chief of the Government Food Distribution Agency for the area of Sulawesi and the Moluccas, and the captain of one ship wrote a letter to the port authorities stating that he could not be responsible for shortages of cargo in Makassar or any other Indonesian port because of such conditions. A short time earlier a British sailor was murdered one night in the dock area, allegedly because he had stopped the theft of burlap bags during the day.

Approximately 50 miles from Pare-Pare on the southwest coast of Sulawesi is the Sadang irrigation works. Before the war under the Netherlands East Indies Government, a diversion dam was constructed on the Sadang River, which with its control structures, distribution canals, and two large pumping installations (planned but not completed) would provide irrigation water for 155,000 acres primarily for rice and corn. Construction was interrupted by the war,

and the plans, topographic maps, and other data were lost. The structures themselves have been damaged, but the exact extent is not known to provincial officials. While it is doubtful that there are enough surveyors and engineers to make the necessary surveys and to complete the plans for the repair and completion of the project, it is also questionable whether the work could be undertaken with safety for the surveying crews. A portion of the damage is said to have been repaired by the people of the area without any engineering supervision, but the real condition of the project is rather vague. One oddity of the security situation is the apparent _laissez faire_ for officials of _Pertanian_ (agriculture) who travel almost at will throughout the area during daylight hours after checking with police and local officials so as to avoid "hot-spots". In view of this apparent appreciation on the part of the guerrillas for the efforts of the Farmers' Agricultural Service (_Djawatan Pertanian Rakjat_) to help the people, one can only wonder whether the security problem would not be completely eliminated if a really strong, well organized, well directed program by all of the government services could be implemented.

The remaining troublesome areas from the standpoint of security are the provinces of Central and West Java. In these two provinces and especially in West Java there are bands of thieves, guerrillas, and religious fanatics varying from only a few men to the size of a regiment. About November 1951, a battalion of the Indonesian Army rebelled and began guerrilla operations in Central Java. Since that time there have been numerous engagements, varying in intensity from light patrol actions to almost pitched battle, between this battalion and those of the Army or Mobile Brigade detachments of the National Police with the battalion suffering severe losses and being dispersed through the mountains along the Central-West Java line.

Another especially troubling element operating principally in West Java has been the Darul Islam group. This group is led by religious fanatics who would have Indonesia as a Moslem state with all other religions excluded by law and force. This is a real problem group because, according to usual estimates, from seventy to eighty percent of all Indonesians are Moslems. Action against the Darul Islam group presents a delicate problem because all-out action might be interpreted in some circles as persecution for religious reasons as opposed to the Constitution, which guarantees freedom of religion for all.

In the press comments relative to the security situation one cannot fail to notice the frequent references to the possibility of foreign leadership in some of these guerrilla bands with two or three Dutchmen occasionally referred to by name. There is no indication, however, of any specific Communist influence. The extent of the difficulties caused by lack of security may be better visualized by examination of statistics published in an English language newspaper in Djakarta[1]. During the first six months of 1952 the total property damage from fire and looting was 12.4 million rupiah, of which 8.6 million was in the first quarter and 3.8 million in the second. There were 3500 homes burned in the first quarter and 1770 in the second. During the same period 850 people were murdered (320 first quarter, 530 the second quarter), 11,680 people robbed (6,940 first quarter, 4,740 second quarter), 120 people kidnapped (60 each quarter), and 190 people assaulted (140 first quarter, 50 second quarter). The above figures are from reported incidents only, and the majority of these occurred in two residencies (Priangan and Rjirebon). No included in the above data are the number of attacks upon police detachments which presumably might be to replenish supplies of weapons and ammuniton.

In general, it is not possible to say that there is a definite pattern to the above attacks, although many of the people robbed, assaulted, kidnapped, or killed are the European personnel of the agricultural estates who are predominately Dutch. It seems quite probable that this fact is true because such personnel are likely to have more money or valuables on hand than most Indonesians. Numerous pay-roll robberies have occurred as estate employees returned from banks in the cities. Most of the houses

1. Times of Indonesia, West Java Sdcurity Conditions in 1952, Djakarta, Oct. 1, 1952.

burned have been in the small villages where a large percentage of all buildings are constructed with wooden or bamboo pole frames, woven bamboo walls, and thatch roofs; all are highly inflammable and so closely spaced that once a fire starts, it is almost certain that the entire village will be destroyed, especially since fire fighting equipment is not available. Even in Djakarta a fire in August 1952, destroyed more than 800 homes and buildings in spite of efforts of the fire department.

In sharp contrast to the troubled areas described above are the security conditions in the remainder of Indonesia. In Kalimantan, Sumatra, East Java, Madura, and all the islands of the Lesser Sunda group, there is little concern over the safety because robberies or other crimes occur infrequently, and one may travel without danger throughout the day or night. The fact that it is not safe to travel at night in some parts of Central and South Sumatra, except possibly by automobile, because of tigers again illustrates the difficulty of making general statements relative to security or to any other subject for large areas of Indonesia.

There is a general inter-mingling of the security, economic, and political situations in each area and for the nation as a whole in that where security is poor, production is below capabilities of the area and there is little confidence of the people in the government's ability

to improve the general welfare. There is an increasing demand from several provinces for more autonomous authority and freedom of action in local matters and this recognition being generally expected by some provincial officials after general elections are held. Prime Minister Wilopo in a press conference on September 30, 1952, stated that general elections would probably be held in the first quarter of 1953, but with the mechanical difficulties of transportation and communication coupled with the great difficulty of satisfactorily informing the illiterate masses of people, this was an optimistic prediction, a prediction impossible to fulfill because in June 1953, the proposed election law was still the subject of parliamentary debate.

The lack of stability in economic affairs, in security, and in political affiliations is indicated most strongly by the number of cabinets that have been formed since President Sukarno's Proclamation of Independence on August 17, 1945. In the five years prior to the formation of the unitary state on August 17, 1950, eleven different cabinets served; three have served since that time. The Constitution provides that the cabinet may be dismissed by the President or may be dissolved by a vote of no-confidence in Parliament. To date the President has not used his power because each cabinet has been dissolved after a vote of no-confidence by Parliament or has resigned before such a motion could be brought to a vote. While this

Parliamentary action indicates the intention of the leaders of the Republic to establish in years to come a true democratic state, it is more strongly indicative of the political maneuvering between and within the various political parties.

Such a change in cabinets occurred on February 23, 1952, when the Cabinet resigned under threat of a no-confidence vote in Parliament. While there were several sources of Parliament's dissatisfaction, there was also internal dissention within the entire cabinet. The final crisis stemmed from the secret negotiations on American assistance by the Minister of Foreign Affairs with the Ambassador of the United States of America. According to Roth[1] there was a general consensus of opinion in Parliament and in the Indonesian press that the agreement jeopardized the nation's independent foreign policy. Having just eliminated the yoke of colonialism, the Indonesians are perhaps hyper-sensitive about any more foreign influence in their internal affairs than the Round Table Conference agreement left them with, and they are very definitely opposed to a firm alliance with either the East or West in the power politics of the world.

Previous to the Foreign Minister's signing of the "note of understanding" on assistance to Indonesia under

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1. Andrew Roth, Indonesian Government Crisis, Far Eastern World Affairs, 45 Dorset St., London, May 1952, pp. 11-12.

the Mutual Security Agency, he had met opposition in the Cabinet and Parliament on sending a representative to the Japanese Treaty Conference in San Francisco and the signing of the treaty. About the same time the note was signed, it became apparent that discussions with the Japanese regarding reparations would be terminated without agreement, a condition which added to the dissatisfaction of Parliament and some of the Cabinet with the foreign policy. An article entitled Difficulties of Cabinet Formation[1] stated that the settlement of the Darul Islam question and the method of establishing local representative councils were among the most important domestic questions contributing to the crisis. Initially critics demanded that the Minister of Foreign Affairs resign, and his resignation was submitted but was followed almost immediately by the resignation of the entire Cabinet in the face of opposition in Parliament that seemed strong enough to pass a vote of no-confidence. The Vice-President, however, stated that the Cabinet fell not because of parliamentary opposition but because of its own weakness. In spite of the fact that the Cabinet crisis was brought to a head by the Mutual Security Agency negotiations and the commitment made by the Minister of Foreign Affairs, on the night following the

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1. Ministry of Information, Difficulties of Cabinet Formation, Indonesian Affairs, Djakarta, Indonesia, Feb.-Mar. 1952, pp. 1-7.

Cabinet's resignation the Government announced by radio that, since its legal representative had made a commitment, the terms of the commitment would be honored in order to maintain the international reputation of the nation.

In view of the fact that the average life of cabinets is six months, it would seem that there could be no continuity in government functions and services, but such an observation is not entirely true. Actually it would be more accurate to say that the average life of the cabinets has been five months with a period of approximately one month required for the formation of each new one, during which time the former Cabinet might continue to function. In each ministry the director of administration and operations is the Secretary-General, and from this level down there are infrequent changes. For example, the Secretary-General in the Ministry of Agriculture has served under eleven cabinets. Just as in the United States Government, cabinet members often change, but department employees below the top echelon and the general public observe little change in basic policy for a considerable length of time. Certainly there may be exceptions if basic policy changes occur between successive cabinets, but as for continuity it would amount to the government employees observing new regulations and instructions. Another factor contributing towards effective continuity is that of retention of former ministers as advisors to the incoming cabinet. In several instances

ministers serving in the present cabinet have served as ministers in other cabinets, but perhaps in different ministries.

A brief summary of the status of assistance from the United States should be given because it has received so much attention since January 1952. Soon after the new Cabinet took office on April 4, 1952, it was announced that the agreement would be honored but that renegotiation efforts would begin immediately to obtain an agreement mutually acceptable and to eliminate the clause referring to military assistance which was unacceptable in Indonesian political circles. While these negotiations were continuing in Washington and Djakarta, the United States Congress passed legislation transferring the assistance from the Mutual Security Agency to the Technical Cooperation Administration or Point IV under the State Department. In September 1952, the Indonesian press announced that the Indonesian Ambassador in Washington had reached an agreement in principle with the State Department for the annulment of the previous agreement and for Indonesia to receive assistance under the Technical Cooperation Administration with any military supplies or assistance to be received on a reimbursable basis without any commitment relating to the mutual security of the two nations. The agreement for Technical Cooperation Administration assistance was completed and approved by both governments January 10, 1953.

It remains that the greatest problem of Indonesia, political or otherwise, is the educational level of the masses. Estimates usually state that ninety percent of the population are illiterate, and until this condition can be materially improved, democracy will advance slowly. The age old custom of deference to age and social position will for many years be reflected not only in elections but in every line of activity of the people. The former rajahs, sultans and village leaders, many of whom are nominally without rank in the present government, have automatically become the most influential citizens in their respective areas so that for a long time it is likely that even with voting franchise the mass of people will have little real influence in the government.

CHAPTER V

EDUCATIONAL BACKGROUND

The lack of education is one of the greatest difficulties, if not the greatest difficulty, facing this young nation. In no field of endeavor are there enough qualified personnel to fill the needs; however, the Ministry of Education is undertaking bold steps to rectify this condition as soon as possible, but it will be many years before the educational system will approach an adequate standard, either quantitatively or qualitatively. The Ministry of Education estimates the Latin alphabet illiteracy[1] at 81.6 percent. There are many Indonesians who are able to read and write in Arabic or in their native language but who have had no education in the languages which use the Latin alphabet. The prevalence of illiteracy presents an insurmountable obstacle for rapid progress, development of resources, or even the dissemination of information. In order to materially reduce illiteracy the Ministry of Education has initiated a mass educational program to teach reading, writing, and arithmetic to the adult population with classes being conducted in almost every village of the Archipelago. The efforts of the Ministry of Education in the anti-illiteracy campaign are

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1. Ministry of Information, Indonesia Today, Education and Science, Djakarta, Indonesia, 1951, Leaflet, 4 pp.

supplemented by the work of religious and private enterprises. The enrollment in these classes is estimated in the millions, but accurate statistics as to numbers or accomplishments are not available. The adult education program should result in a partially enlightened population which in turn should increase the efficiency of the regular institutions through improved attendance and efforts on the part of the students. Compulsory education through the elementary level is nominal at this time; enforcement in impossible because of lack of facilities and teachers. Of the ten million children of school age only five million are now in school, but according to a statement given to the press by the Minister of Education in January 1953, it is expected that enough schools and teachers will be available by 1960 to permit enforcement of the compulsory education law.

In addition to the educational programs of the Ministry of Education other ministries are conducting a large number of specialized schools and courses in an attempt to fill their own requirements for trained personnel and for the dissemination of information to the people. Some of these courses are short, part-time courses, while others are at the level of technical high schools. In addition to the training being conducted within Indonesia, all ministries are sending personnel abroad for technical training as fast as available personnel and finances permit.

While it is true that the Civil Service of the Netherlands East Indies before World War II employed about thirty thousand Europeans and Eurasians and one hundred and eighty thousand Indonesians - the latter were principally in clerical positions[1]. Typically they were trained to perform tasks very limited in scope and to follow an unvarying routine without necessarily understanding why the routine was established. From the statement of the Indonesian Ministry of Information[2] that only two hundred and forty Indonesians graduated from high school in 1940, it is evident that most of the indigenous personnel in the Netherlands East Indies government had very limited education. In the pre-war days an average of ten percent of the budget was allocated to education, but 88.6 percent of this amount was for the support of schools for European children[3], which admitted only a small percentage of well-to-do Indonesian or other Asian children. A restrictive requirement for entrance in the high schools was knowledge of Dutch, the language of instruction in high schools which was not taught in the elementary schools attended by the Indonesian children. The inadequacy of pre-war schools is best illustrated in the fact that seventy thousand students were turned away from village schools in 1941 because of lack of space.

1. Kennedy, op. cit., p. 51.
2. Ministry of Information, Indonesia, Country, People, Transition and Future, Djakarta, Indonesia, 1951, p. 114.
3. Loc. cit.

The hierarchy of the pre-war Civil Service was in this order: the Governor-General, the provincial governors, the residents, and the controllers[1], each of whom was responsible for the administration of respectively smaller areas. Candidates for positions of controller and above were selected from high school graduates in the East Indies or in Holland by an examining committee, and successful candidates were sent to a Dutch university for five years on government fellowships. With this procedure it is obvious that, while legally it was possible for an Indonesian to compete for and to eventually attain high rank in the Civil Service, the law of averages made it virtually impossible to do so. The candidates selected were well qualified upon completion of their education, which in addition to the usual subjects included special courses in the ethnology, history, law, and languages of the Archipelago.

With the newly acquired independence the few well educated Indonesians and many leaders with inadequate education found themselves elevated to positions of great importance, for which in many cases they possessed insufficient experience to perform the duties efficiently. These officials were further handicapped by the dearth of capable assistants to whom responsibility could be delegated to any appreciable degree, thus slowing down administration by overloading those who filled the upper positions.

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1. Kennedy, op. cit., p. 51.

It is impossible for one to say whether the Indonesian Round Table Conference delegates anticipated the need for technically trained assistants in every branch of the government or whether they agreed to retain former civil servants in advisory capacities simply to facilitate consummation of the agreement. In either case, however, it was agreed that the Civil Service contracts of many Dutch citizens would be continued, even including their former privileges, such as European leave every seventh year and retirement after twenty years with leave and travel time outside of Indonesia considered half-time.

In addition to the former employees, additional Dutch personnel were employed on contracts of two to three years to assist in almost every element of the government, and almost all were given the title of advisors. In many department where the Dutch personnel concerned have been willing to accept the new status and to work with Indonesians who now fill the responsible positions, the arrangement has been excellent. In other departments the results have been far from harmonious, either because the Indonesian hesitated to ask for advice or assistance from his advisor for fear it would prove him unqualified or because the advisor longed for the "good old days" when he was able to give directions rather than recommendations which today may be ignored. As contracts expire, many are not being renewed; others are being renewed for shorter terms; some advisors are resigning because they feel that their

capabilities are not properly utilized.

Additional technical assistance in many fields is being obtained through contracts with vendors, especially in the machinery field, and through the technical assistance programs of the United Nations and of the United States of America. In December 1952, Indonesia became a participating country in the Colombo Plan which provides mutual technical assistance and training, primarily with the Asian Commonwealths of the British Empire. In some technical fields contracts are being awarded for equipment completely installed with technical personnel supplied by the vendor to train Indonesian personnel in its operation. The assistance from the United States was administered by the Economic Cooperation Administration until January 1, 1952, by the Mutual Security Agency from January 1 - June 30, 1952, and by the Technical Cooperation Administration under the State Department after July 1, 1952. The total amount of technical assistance from the United Nations and from the United States is relatively small when compared to that being financed from Indonesia's own resources.

In education as in most other phases of the government, Indonesia is faced with two fundamental problems. The immediate concern is that education is in itself twofold, in that the educational level of the mass of the people must be raised sufficiently to permit them to participate intelligently in the democratic processes of

government and simultaneously it must also furnish enough technically trained personnel to permit the government to provide minimum acceptable levels of efficiency in serving the people in communications, transportation, agriculture, and health. The second fundamental problem in education is the establishment of a system of elementary, secondary, and vocational trade schools, as well as institutions of higher learning, adequate to provide the future requirements in all professions in order to permit the improvement and expansion of agriculture and the development of basic industry which, in conjunction with the exploitation of human and natural resources, will enable Indonesia to sustain a balanced, stable economy.

One of the multitude of problems confronting Indonesia has been and for a time will continue to be the absence of a common language. While the lingua franca of the Archipelago is basically Malay, the variations between various areas has made the two hundred spoken languages[1] mutually unintelligible. Malay has been spread throughout the coastal areas by traders and fishermen, while the inland areas have developed languages of their own, but before the war Dutch was the official language. Indonesians who attended school beyond the primary level had to learn Dutch before being admitted because it was the language used for instructions. In the pre-war nationalistic period of the

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1. E. Pino, Bahasa Indonesia, J. B. Wolters, Djakarta, Indonesia, 1950, p. 3.

1930's, the need for a common language gained considerable importance and the Indonesian language, bahasa Indonesia, began to spread through the Archipelago. Its spread was accelerated by Japanese occupation laws which forbade the use of all languages except Japanese and Malay. Many Indonesians used Indonesian for the first time during the occupation, having previously used only their local dialects and Dutch. The provision that Indonesian was the official language was included as article thirty-six in the Provisional Constitution of the Republic of Indonesia of August 17, 1945.

Because the Dutch language is no longer a required subject in high schools, the new Indonesian language is a serious problem in the colleges and universities at the present time. Many of the instructors have never used the Indonesian language before except for shopping in the markets and with servants and are unable to adequately explain technical subjects except in Dutch, and many students now attending these schools have studied little or no Dutch. The problem is further complicated by the inadequate supply of textbooks, especially in science, except in Dutch or English. Often government officials revert to the Dutch language for technical discussions. English has been adopted as the basic foreign language and is required for all students beginning in the seventh year, which is the first year of junior high school.

The approach to the problem of raising the educational level of the mass of the people is through private or government anti-illiteracy schools[1] in every desa (village), which are using books especially prepared for this purpose. In the field of general information, dissemination is accomplished through newspapers, moving pictures, mobile public address systems, and the government-owned radio stations. Because most of the population in the villages is financially unable to subscribe to the newspapers, in most villages the Ministry of Information maintains bulletin boards on which newspapers and bulletins are posted. Elementary schools are being established as fast as possible with attendance for a minimum of three years, nominally compulsory. It is impossible to enforce the regulation at this time because in some areas there are inadequate school rooms and insufficient teachers even when using the American standard of fifty years ago that teachers must have progressed at least one or two grades beyond the one being taught. The basic approach is to establish the lower grades most rapidly with the higher grades to be added as soon as possible.

Beyond the elementary schools the pattern is generally the same with schools being established as soon as facilities and teachers are available and in some cases before adequate facilities or well qualified teachers are available.

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1. A press release in May 1953 by the Ministry of Education stated that through the mass education program 45 percent of the population is no longer illiterate but did not define the degree of literacy thus attained.

The manner of approach indicates a feeling of the Indonesians that the establishment of an adequate system of schools must become a fact as soon as possible and that the facilities must be improved in the immediate future. The logic of this approach becomes apparent if one realizes that the graduates of inferior schools are better qualified for positions of responsibility than those who have had no opportunity for school attendance. The extent to which existing facilities are often used was seen in Medan (Aug. 1952) where the author inquired about classes being conducted in one school at night. The answer was to the effect that there was a morning school, an afternoon school, and a night school in that building.

The general objective of the elementary school is to provide for everyone a basic education which will include instruction in Indonesian, the provincial dialect, basic mathematics, history, and the arts and culture of Indonesia. Beyond the elementary school a student may enter either the high school or the vocational high school. The principal objective of the high school is preparation for college or university study, while the objective of the vocational high schools is to train an adequate supply of sub-professional or skilled labor in various fields of endeavor. English is a required subject for all students who enter either type of high school.

Comparable to the organization of American universities,

the Indonesian universities are divided into faculties (colleges) for medicine, law, economics, engineering, agriculture, general sciences, and arts.

At the present time there are two universities, the State University of Gadjah Madah with its six faculties in Djogjakarta, and the University of Indonesia with five of its faculties in Djakarta, two in Bogor, three in Bandung, two in Sourabaja and one in Macassar. The teaching staffs, of the two universities number more than four hundred but this number includes many part-time lecturers who hold other positions in the Government. For example, the Chief of the Irrigation Service of the Ministry of Public Works and Power also teaches irrigation at the faculties in Bandung, Bogor, and Djogjakarta. In 1950 there were almost five thousand students enrolled in the various faculties, but the enrollment has materially increased at this time.

The general outline being followed in the establishment of the Republic's education system is shown in Figure 2.

Sekolah Rakjat

Elementary School
(6 yrs.)

Technical		Special
Sekolah Technic Pertama	Sekolah Menengah Pertama	Sekolah Guru
Technical Junior High School (3 yrs.)	Junior High School (3 yrs.)	Teachers Training School (4 yrs.)
	Sekolah Menengah Atas	Sekolah Rumah Tangga
Sekolah Technic Atas	Senior High School (3 yrs.)	Domestic Schience School (3 yrs.)
Technical Senior High School (3 yrs.)	Universitiet	Sekolah Ilmu Dagang dan Lain2
	University 3 yrs. BS Degree 5 yrs. Masters or Ingineurs Degree	Commercial and other Special Schools
		Sekolah Pertanian Menengah Atas
		Agricultural High School (3 yrs.)

Figure 2. Schematic diagram of general organization of educational system

CHAPTER VI

COMMUNICATIONS

The combined area of islands, intervening seas, and straits is almost as great as the entire North American continent (Fig. 3). More than two hundred of the islands are inhabited; however, only about thirty-five are really large enough to be of agricultural or economic importance. This fact in itself presents another problem to the already burdened government because administration and services must be provided for small segments of the population in isolated areas where the volume of trade is insufficient for a self-supporting transportation system.

Under three hundred and fifty years of Dutch colonial administration, first by the Netherlands East Indies Company and later by the Netherlands Government, the greatest development was made on the islands of Java, Madura, and in parts of Sumatra. Other islands that are well known but developed to a lesser degree are Kalimantan, Sulawesi, the groups known as the Lesser Sunda Islands, and the Moluccas. Kalimantan is the new name for Indonesian Borneo, while Sulawesi is the Indonesian name for Celebes. Bali is probably the best known of the Lesser Sunda Islands which also include Flores, Sumba, Sumbawa, Lombok, Timor, and others. In addition to its worldwide fame as a tourist attraction, Bali is also noted locally for its agriculture

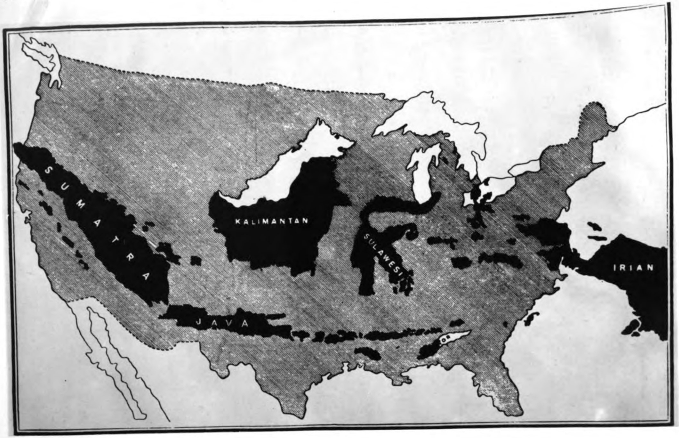

Figure 3. Map of Indonesia overprinted on map of the United States (Courtesy of Indonesian Embassy, Washington, D.C., and Ministry of Information, Djakarta)

because its adat (native custom) method of distribution of irrigation water is well regulated through village councils and is known as the subak system. Because most Balinese are of the Hindu religion, there is no religious taboo against pork, and swine is one of the principal exports of the island, most of which is shipped to the cities of Java and to Singapore (Figs. 4, 5). In the Moluccas, Halmahera is the largest island, but in the struggle between European powers of the sixteenth and seventeenth centuries for control of the area it was overshadowed in importance by the small islands of Ternate and Tidore. These small islands were the homes of the strongest sultans of the period, and it was through them that most efforts were made to control the spice trade. At Ambon on the small island of Amboina the Dutch developed a fine harbor and naval base which must be well known to many Allied aviators from the number of wrecked airplanes and hulls of sunken craft still visible on the island and in the bay.

It is almost impossible for one unfamiliar with the Far East to visualize the problems, the equipment, or the difficulties of transportation within this archipelago. The range of transportation facilities is complete with the pikulan or shoulder pole used by men and with baskets carried on the heads by women at the primitive end of the scale and with four-motored transport planes at the other.

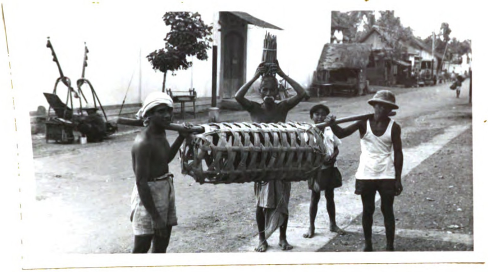

Figure 4. Hog carried in a bamboo basket in Bali

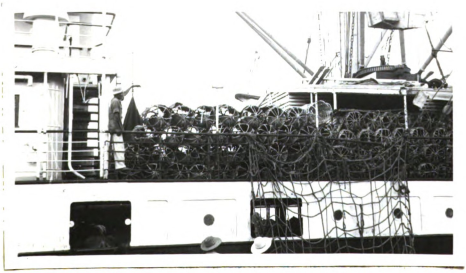

Figure 5. Inter-island steamer loaded with swine and cattle

Between these extremes are the two-wheeled carabao and bullock carts; horse carts; dug-out canoes; bicycles; *bet-jaks* or three-wheeled pedi-cabs; motor cycles; both out-board and inboard motor boats, as well as paddle-wheel river steamers and sea-going sailing vessels; wood burning, coal burning, and electric trains; and all types of European and American automotive equipment.

The farmer usually transports his small surplus of farm products to the *pasar* (market) by *pikulan* (Fig. 6) or with his two-wheeled cart (Fig. 7) if he is wealthy enough to own a carabao or bullock. At the *pasar* much of the produce is sold directly to consumers, but some is purchased by traders who use trucks for moving the produce to the larger markets of the towns and cities. In the vegetable producing area of Brastagi, south of Medan, an estimated daily average of thirty tons of vegetables is hauled by truck to Medan's port of Belawan for export to Singapore. In Kalimantan the first stage of the farm to market transportation more often than not is by dug-out or, to describe them more exactly, burned-out canoes. In Banjarmasin and Kuala Kapuas, as well as in many other places on Kalimantan and other islands, much of the trading is between the small proas in which the produce of these virtually roadless areas is brought to market (Figs. 8, 9).

On Java, Madura, Bali, and Sumatra a system of roads was constructed before the war, but in general they are

Figure 6. Transportation of produce with pikulan

Figure 7. Transportation by means of ox-cart

Figure 8. Canoes used to transport commodities to market in Kalimantan

Figure 9. Small cargo boat on Musi River in South Sumatra

inadequate for the heavy post-war traffic and many areas remain isolated. Due to the lack of equipment, equipment operators, maintenance and technical personnel, much of the direct war damage and the deterioration from lack of maintenance during the occupation and post-war struggle for independence has not been repaired, or if so, on a temporary basis. At several locations in Sumatra it is necessary for everyone except the driver to dismount from automobiles and walk across bridges which were damaged during the revolution and have been only partially repaired to date. On Flores, Sumba, and Sumbawa the rate of destruction of bridges by the annual floods of the rainy season has exceeded the ability of the Ministry of Public Works to replace them; therefore, most streams must be forded. During the dry-monsoon this necessity is of no particular consequence because many of the streams are dry and others are at low stage; however, a week after the beginning of the wet-monsoon in 1952 it was necessary to travel on Sumbawa in a 1½ ton truck because the streams were too deep for fording in automobiles and pickups. The problem of flood damage to bridges is common throughout Indonesia, so common that before the war the Government-owned railways kept pre-cut bridges to enable the prompt replacement of those bridges over Javanese streams which were most often damaged by floods. Figure 10 shows a highway bridge on a secondary road in West Central Sumatra which was damaged

Figure 10. Flood damaged bridge on secondary road in West Central Sumatra

Figure 11. Four lane highway near Djakarta

by floods early in 1951 but had not been repaired in July of 1952. Although traveling in jeeps, all the passengers had to dismount and walk across the bridge at the time of a visit to this area.

On islands other than those previously referred to, roads are normally found in the most densely populated areas and connect the principal places of importance (Fig. 11). Kalimantan has the least adequate system of roads of the major islands with a total mileage of only about one thousand[1], of which approximately five hundred miles is in the vicinity of Bandjarmasin, approximately one hundred miles in the vicinity of Balikpapan, and approximately four hundred miles in the vicinity of Pontianak. No connecting roads between these three population centers necessitates travel by ship or plane. There are regular flights between Bandjarmasin and Balikpapan, but Pontianak may only be reached via Djakarta and Palembang; for a provincial official to travel from the provincial capital at Bandjarmasin to Pontianak he must travel through at least two other provinces and perhaps four, depending upon whether the first leg of his journey is directly to Djakarta or via Surabaja and Semarang. Via this air route he may reach Pontianak in two days with an overnight stop in Djakarta. The alternate choice of travel, by ship,

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1. L. W. Hannibal, Peta Kalimantan, 1/2,500,000, Planning Division, Forestry Service, Ministry of Agriculture, Bogor, Indonesia, 1950.

requires three to five d ays, but the infrequency of regularly scheduled vogayes normally makes this choice impractical. The lack of roads in Kalimantan is forcefully reflected in the lack of correlation between its area and its road mileage. Although the island's 203,000 square miles is more than a fourth of the total land area, its one thousand miles of roads is only about one-fortieth of the 39,562 miles[1] in the road network of the country.

The only railroads are on Java and Sumatra and a ferry transports the railway cars from Merak, West Java, across the Sunda Strait to Tandjung Karang, South Sumatra. The railway system on Java connects the principal cities, and with recent imports of locomotives and coach or freight car chasses, the railroads are able to provide daily service. On Sumatra there are three areas with rail service, but without interconnections. The South Sumatra railway service operates from Tandjung Karang on the south coast to Palembang and thence inland to the northwest. On the west coast a cog-line connects Padang and Bukit Tinggi, and in the north a narrow-gage line runs from Medan to the Achin territory. The total length of rail lines is 4,610 miles[2]. Many estates have private narrow-gage railways for plantation to processing plant transportation, but these are of no value to the public transportation system.

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1. Ministry of Information, Indonesia Today, Communications, Djakarta, Indonesia, 1951, Leaflet, 4 pp.
2. Loc. cit.

Intra-island, as well as inter-island, transportation is both by ship and air, while farm products and farm equipment ordinarily are transported by land or ship. Poultry products, vegetables, fruit, and flowers are regularly flown from Bandung to Djakarta and to Palembang in South Sumatra. Table II shows the extent of air travel and transport for the operations of the Garuda Indonesian Airways jointly owned by the Indonesian government and by the Royal Dutch Airlines and operated under the management of the Royal Dutch Airlines. Except for one flight per week to Manila, Philippine Islands, and one flight per week to Bangkok, Thailand, and almost daily service between Sumatra and Singapore, Malaya, all flights of this company are within Indonesia.

Inter-island shipping is a virtual monopoly operated by the Koninklijke Paketvaart Maatschappij (Royal Packet Company) under a government franchise, and this company in return for this concession must make regular calls at many isolated ports that would otherwise by by-passed. In spite of the size of its fleet, which includes a total of 108 ships with a total registered tonnage of slightly more than two hundred thousand tons[1], there is inadequate shipping. The Governor of Central Sumatra in December 1951 stated that the only Indonesian cement factory at Padang

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1. Koninklijke Paketvaart Maatschappij, N.V., _Dienstregeling der N.V. Koninklijke Paketvaart Maatschappij voor het Jaar 1953_. Djakarta, Indonesia, Nov. 1952, 135 pp.

TABLE II

GARUDA INDONESIAN AIRWAYS OPERATION SUMMARY

	1949[a]	1950	1951[b]
Total revenue hours flown	39,583	40,371	37,134
Total revenue miles flown	5,004,000	5,135,000	5,708,000
Total ton/miles available	14,239,000	15,032,000	15,598,000
Total revenue ton/miles	10,198,000	11,169,000	12,046,000
Revenue load-factor	71.6%	74.3%	77.2%
Number of passengers carried	266,000	293,000	297,000
Average distance in miles per passenger	264	280	300
Total revenue cargo, mail plus excess baggage and freight	22,339,000	22,032,000	24,160,400

a. In 1949 the operation was by KLM-Interinsular airlines
b. Total planes 8 Convairs, 22 CD-3's, 6 Catalina amphibians

could not operate at more than two-thirds capacity because of lack of transportation in spite of the nation's great need for cement for reconstruction. There may be other factors affecting the cement production, but without increased shipping increased production would have little value.

The term virtual monopoly is used above because a large number of native sailing craft are in constant use along the coast and between islands. An undetermined number of these also sail to Singapore and to the Philippines to conduct an illicit trade known to be of considerable volume in order to avoid import and export taxes which are high. The control of smuggling is impossible at this time because of the limited number of ships and of personnel available for patrolling the great length of shoreline. In order to supplement the shipping available within Indonesian waters, the Government has sixty 500-ton coaster type vessels on order in Europe for delivery in 1953-1954. Presumably these vessels will be operated by a national shipping company, but whether it will be under the Ministry of Communications or through an Indonesian company has not yet been announced. Presumably these additional ships should ease the shipping difficulties somewhat, but it may result in an even greater problem. Because the Koninklijke Paketvaart Maatschappij is a Dutch corporation, there are rumors to the effect that, if their monopolistic control of

inter-island shipping is confronted with serious competition, they may transfer the entire fleet to some other part of the world.

The overall problems of transportation and communications are a reflection of the lack of heavy industry in the Republic. All automobiles, motorcycles, and bicycles are imported, and only two companies even have automobile assembly plants within the country. There are several companies which manufacture small machinery and implements, but heavy machinery and all types and sizes of internal combustion motors and steam engines are imported. There are many small shops which make wooden bodies for trucks and buses in the various cities, and the railroad yards make wooden freight car bodies for imported chasses. Small shipyards in Djakarta, Palembang, and Surabaja are capable of building fifty to one hundred ton boats but also depend upon imported steel and motors.

The handicap of too little transportation within the Archipelago, as well as with other parts of the world, has long retarded the development of the natural and agricultural resources. In 1952 the export of livestock from the island of Sumba in the Lesser Sunda Islands, where the production of livestock is the principal type of agriculture, was limited to eight hundred animal units per month; for shipping purposes the small horse, approximately six hundred pounds, is considered an animal unit, an Angol

(Brahma) cow equals 1.4 units, and a carabao equals 1.6 units. Similarly, the export of livestock, copra, coffee, and other crops is limited by the availability of shipping throughout the Eastern Islands, and at times temporary shortages of rice occur in these islands because of the difficulty of importation resulting from inadequate transportation. Ohter commodities are also frequently in short supply for the same reason; for example, in November 1952, on Sumba the supply of gasoline for the island's estimated one hundred motor vehicles gave out approximately three weeks before the next shipment was due to arrive.

The mining of tin on the islands of Bangka and Billiton off the southeast coast of Sumatra is the oldest development of mineral resources of economic importance in the Archipelago. It is reported by Ter Braake[1] that the Dutch East Indies Company bought tin from the Sultan of Palembang as early as 1710. This early development was possible only because the small size of the islands precluded the necessity of appreciable inland transport, and the proximity of the islands to the international shipping lanes around the Malayan Peninsula made the export of tin possible and profitable.

Coal has been mined on a large scale in Central and South Sumatra only. Approximately thirty miles east of

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1. Alex L. Ter Braake, Mining in the Netherlands East Indies, Bull. No. 4, Netherlands and Netherlands East Indies Council of the Inst. of Pacific Relations, New York, 1944, p. 36.

Padang is the Ombilin coal field; however, before it could be exploited, it was necessary to build a narrow-gage railway about one hundred miles in length across the Barisan Mountains. Because of the slopes involved a part of this railway had to be constructed as a cog line[1]. The most important coal field is that at Bukit Asem, about eighty miles inland from the South Sumatra port of Palembang but 110 miles via the railway constructed to permit the development of the area. The annual pre-war production of the above areas was slightly more than 1½ million tons, and the combined production of areas on Kalimantan's East Coast totalled a little more than one-half million tons. In other areas of Kalimantan, Sumatra, and Java the cost of transportation has caused the failure of a large number of small coal field developments for commercial production.

The development of other mineral deposits has been retarded by the lack of or the cost of transportation. The same statement is true for agriculture of the Outer Islands and for natural resources such as timber. In addition to the problems and the cost of transportation within the country, the cost of imported material for the development of the nation's economy is far greater than in Europe or North America.

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1. Ibid., pp. 59-65.

Telephone circuits are available in all of the major cities, and even in the most remote areas there are usually one-wire systems connecting the towns and principal villages. Inter-island radio-telephone connections are possible between the provincial capitals for a few hours each working day, and from Djakarta, Bandung, and Medan there are facilities for international calls. The municipal circuits are manual switch boards systems that normally are overloaded because of the vast increases in the population of the urban areas since the war and also in some cases because of the poor condition of the system for lack of maintenance personnel and material. Telegraphic services between the major cities are satisfactory and the same is true for international radio telegraphic communications.

There are 37 government owned radio transmitting stations[1] which broadcast daily programs designed for entertainment, eduction, and current events. The regional stations are bi-lingual with programs in both the Indonesian language and in the local dialect. The stations in Djakarta carry programs in the Indonesian language as well as in foreign languages - Dutch, French, English, Chinese, Arabic, Hindi, and Urder.

In the field of communications, as in most other fields of importance to the economic development of Indonesia, the framework or foundation for an adequate system

1. Ministry of Information, Indonesia Today, Communications, op. cit.

is present. Upon the existing foundation there must be a vast expansion and improvement if communications are not to become the principal factor of delayed development in the future. At this time the effectiveness of efforts to improve rail communications must first come from the police or from the Army because present facilities cannot be used to capacity due to derailings and banditry in East and Central Java. There can be little increase in efficiency from improved roads or equipment when the rail workers are refusing to work because of lack of safety along the railroads. There is a real need for increased transportation for people within the municipalities, for increased internal transportation by rail, motor vehicles, and river boat, coastal steamers and pipe lines if the potential of the country is to be attained.

CHAPTER VII

CLIMATE, VEGETATION, AND SOILS

A. General Characteristics

If one studies Southeast Asia maps, he will observe that the Indonesian Archipelago is the apparent extension of mountain chains from Burma and from the Malayan Peninsula. The Burma chain extends in a southeasterly direction through Sumatra and bears eastward through Java and the Lesser Sunda Islands, while the extension of the Malayan chain seemingly passes through Bangka, Billiton, and thence northeast through the northwest mountains of Kalimantan. In commenting on this relationship Vlekke[1] concludes that prior to the end of the last glacial period these islands were connected to the Asian Continent by the present bed of the shallow Java Sea. Similarly, he concludes that the relatively shallow Arafura Sea came into existence at the same time to separate New Guinea and numerous smaller islands from the Australian Continent. Sulawesi and Halmahera seemingly have not had such recent geological connections with either Continent as their flora and fauna do not conform to either the Asian or the Australian types, and they are separated from adjacent land masses by deep seas and straits.

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1. Vlekke, op. cit., p. xii.

With considerable risk of over-simplification of the geological history of the Archipelago, it may be described as having developed through a series of pre-tertiary, tertiary, and quaternary uplifts with most areas being influenced by either submarine and/or aerial volcanic eruptions. There have also been the opposite effects either of subsidence or of rising seas as referred to above. This is an area of the earth where the face is still subject to considerable change at relatively frequent intervals. Islands are still being formed and are disappearing, the most important recent example being the eruption of the Krakatau Volcano in the Sunda Strait between Sumatra and Java in 1883. With its eruption so violent that its ash has been identified from all parts of the world, this island virtually disappeared below the water.

Volcanos occur at frequent intervals throughout Sumatra, Java, the Lesser Sunda Islands, the Moluccas, and Sulawesi. Kalimantan is the only major island of Indonesia which, from the standpoint of soil fertility, is not blessed by the presence of many volcanoes. Many of Indonesia's volcanoes are inactive, but many others are still in various stages of activity varying from the constant exudation of smoke to rumblings, hot craters, and recent or threatened eruptions. The Seismographic Institute at Djakarta usually records two or three slight earthquakes daily. The extent of volcanic influence is most evident perhaps in the presence of fourteen active volcanoes on the island of Flores, which is only about three hundred and fifty miles in length and seventy-five miles in breadth. The most recent eruption there was that of the Laki-Laki volcano in 1950. In March, 1953 the Sanguang volcano, on a small island north of Sumbawa, erupted volcanic ash and forced the evacuation of its population of about 2,000 people to Sumbawa. The Institute of Volcanic Research maintains a continuous observation of volcanoes, within the capabilities of its personnel, which exhibit signs of eruption both for scientific study and for protection of the population of adjacent areas. Mohr[1] has stated that, because of the influence of earthquakes resulting from volcanic activity, no soil formed on the island of Bali has remained in its original place of formation.

The geological forces exposing the soil forming rocks of Indonesia to the processes of weathering have been sharp and violent. The topography reflects this last fact in that throughout the country the interior areas of the islands are usually rough, steep mountains with an occasional plateau, while towards the coast lines undulating to flat plains have developed. Subsidence along Sumatra's East coast has developed a swamp area approximately seventy-five miles in width and four hundred miles in length in

1. Mohr, op. cit., p. 203.

the juvenile coastal plan. The only other large swamp areas of sufficient size to be of great importance occur on Kalimantan, the principal one being in the alluvial plains of the Barito River and its tributaries which cover more than a million acres. Within the mountainous interiors of almost all the islands there are many level or gently sloping valleys and a few plains developed by the deposition of alluvium in lake beds of other geological ages.

Because of its equatorial position there are no distinct seasons in Indonesia with reference to length of days and temperatures. The difference between the longest and shortest days of the year at Djakarta is only forty-eight minutes. Temperatures also show very slight variations, with the annual range varying only between the mean daily temperatures of 76° to 79° Fahrenheit from a maximum of 91° to a minimum of 71°. Seasons are determined by the direction of the prevailing winds. The southeasterly or, as it is usually referred to, the east monsoon brings relatively dry weather to most of the islands, while the northwesterly or west monsoon brings the relatively wet season. In the Indonesian language no reference is made to the direction of the prevailing winds, but the seasons are simply differentiated as the hot season (musim panas or musim kemarau) and the rainy season (musim hudjan). The term relatively dry is used above because typically that part of the Archipelago lying on or north of the equator has no real dry season. Most of Sumatra, Kalimantan, North Sulawesi, and Halmahera have few months with less than one hundred millimeters (four inches) of rainfall per month; however, the farther south and east one travels the more distinct and severe becomes the dry season. The dry season is especially acute in East Java, South Sulawesi, and the Lesser Sunda Islands with some of these areas approaching the steppe or even desert type of vegetation resulting from the combination of poor soils and marked dry seasons of seven to eight months' duration. Because of the influence of the mountains a distance of a few miles often makes an appreciable difference in the frequency and total amount of rainfall. One of the most marked examples is the comparison of the rainfall of Djakarta, at an elevation of 23 feet, with that of Bogor which is about thirty-five miles away and at an elevation of seven hundred and sixty-seven feet. Djakarta has an annual rainfall of 71 inches with 135 rainy days per year, while Bogor has 167 inches and 216 rainy days per year based on records of sixty-three years.

In Table III precipitation data from seventy-eight rain-gauge stations from all of Indonesia except Irian are given. These data show the mean monthly and annual rainfall, as well as the average number of rainy days for each month and the greatest and second greatest rainfalls per day on record. The selection of these stations from <u>Rainfall</u>

Figure 12. Map showing location of selected rainfall stations of Table III
(Courtesy of Indonesian Embassy, Washington, D.C. and Ministry of Information, Djakarta)

Figure 12. Map showing location of selected rainfall stations of Table III (Courtesy of Indonesian Embassy, Washington, D. C. and Ministry of Information, Djakarta)

TABLE III

PRECIPITATION RECORDS OF SEVENTY-EIGHT SELECTED STATIONS

No.	Name and location of station	Years of record	Elevation feet	Line	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual mean	Maximum record 24 hours	Second largest record 24 hours
					Mean monthly rainfall (line a), Number rainy days (line b), Max. per 24 hours (line c) Lines a and c given in millimeters 25.4 mm = 1 inch														
1	Koeta Radja	63	0	a	149	98	100	112	149	93	97	110	163	176	188	202	1637	-	-
	North Sumatra	-	-	b	10.6	6.6	7.7	8.5	11.1	8.4	8.5	9.4	11.4	13.5	13.9	13.9	123.6	-	-
	(107)*	-	-	c	56	43	40	43	48	37	36	39	50	53	53	57	116**	277	214
2	Lho' Seumawe	47	0	a	199	61	75	89	108	84	82	93	111	163	193	262	1520	-	-
	North Sumatra	-	-	b	9.7	4.7	5.7	6.3	7.8	6.2	5.7	7.4	8.8	11.8	12.1	13.0	99.2	-	-
	(115)	-	-	c	66	28	37	37	41	35	37	35	40	48	56	74	109	197	168
3	Kabandjahe	6	4000	a	128	85	173	171	120	27	40	112	159	203	208	218	1644	-	-
	N.E. Sumatra	-	-	b	4.3	9.3	13.8	14.7	12.5	5.7	6.2	13.3	18.3	18.3	19.4	16.9	159.7	-	-
	(138d)	-	-	c	42	26	49	43	33	15	15	34	29	61	59	48	81	102	86
4	Medan	63	45	a	144	84	107	133	174	131	133	173	214	268	239	215	2015	-	-
	N.E. Sumatra	-	-	b	11.2	6.8	8.3	9.9	11.6	9.3	8.8	12.9	14.6	17.4	16.9	14.8	142.5	-	-
	(127)	-	-	c	48	37	37	44	53	43	44	44	53	64	56	60	104	262	235
5	Laboehan Bilik	41	0	a	209	129	140	175	156	135	112	190	230	277	279	198	2230	-	-
	N.E. Sumatra	-	-	b	12.3	7.7	8.5	10.5	9.2	7.0	6.6	9.4	12.0	15.5	14.8	12.5	126	-	-
	(148)	-	-	c	54	45	42	49	46	45	39	58	57	58	56	43	93	180	165
6	Sibolga	62	0	a	368	336	448	466	349	263	279	331	381	490	518	433	4662	-	-
	(83)	-	-	b	17.7	14.7	18.5	19.7	15.8	12.4	13.6	15.6	17.4	21.0	21.0	20.2	207.6	-	-
		-	-	c	86	90	105	92	89	76	83	92	91	92	99	94	170	439	312
7	Ophir C.M.	6	185	a	252	264	348	398	362	156	152	319	386	488	449	501	4075	-	-
	W. Central Sumatra	-	-	b	16.6	15.5	17.8	21.3	17.2	11.3	10.7	15.8	19.4	22.2	24.0	22.2	214	-	-
	(59d)	-	-	c	55	62	92	87	84	38	47	95	81	85	84	90	130	144	140
8	Bukit Tinggi	63	3100	a	251	155	218	260	160	113	86	146	205	244	238	305	2381	-	-
	W. Central Sumatra	-	-	b	16.2	12.9	16.5	19.5	14.9	10.8	10.1	14.7	18.4	20.1	22.4	22.2	198.7	-	-
	(54f) formerly Fort de Kock		-	c	62	43	49	51	42	34	31	33	40	47	51	51	82	170	92
9	Padang	63	17	a	352	357	309	368	325	297	267	349	411	510	520	488	4453	-	-
	(44)	-	-	b	16.2	12.8	15.7	16.8	14.3	11.2	11.7	14.4	16.7	20.4	21.2	19.7	191.1	-	-
		-	-	c	91	80	82	96	94	104	81	109	108	111	112	103	193	282	270
10	Djambi	63	33	a	225	199	267	251	190	128	111	147	161	237	291	267	2474	-	-
	E. Central Sumatra	-	-	b	16.9	13.9	17.2	16.4	13.2	9.8	9.0	10.8	11.4	15.4	17.6	18.7	170.3	-	-
	(175)	-	-	c	54	53	58	63	56	43	42	48	46	57	63	60	106	260	237

*Numbers of stations are numbers used in source reference

**Monthly daily maximum, all lines c are average monthly maximum per 24 hours, the annual mean column is average of annual maximum, not obtained from monthly maximums

Continued

TABLE III Continued

No.	Name and location of station	Years of record	Eleva-tion feet	Line	Mean monthly rainfall (line a), Number rainy days (line b), Max. per 24 hours (line c) Lines a and c given in millimeters 25.4 mm = 1 inch Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual mean	Maximum record 24 hours	Second largest record 24 hours
11	Palembang	63	-	a	286	245	311	284	182	121	97	102	110	204	283	321	2546	-	-
	S.E. Sumatra	-	-	b	18.8	15.8	17.9	16.3	12.0	9.0	7.0	7.9	8.1	11.8	16.4	19.6	160.6	-	-
	(191)*	-	-	c	66	57	66	68	57	42	36	40	39	57	61	67	103**	185	173
12	Bengkulen	63	-	a	304	270	292	292	229	187	175	206	234	357	394	359	3299	-	-
	S.W. Sumatra	-	-	b	16.0	13.3	14.9	14.1	11.2	9.3	9.3	10.1	11.2	15.6	17.3	17.9	160.9	-	-
	(13)	-	-	c	75	73	75	78	76	65	63	70	72	85	88	80	147	226	215
13	Negeri Besar	28	95	a	370	330	318	236	170	125	83	78	153	149	243	359	2614	-	-
	S. Sumatra	-	-	b	17.5	15.1	14.4	11.8	10.1	8.4	5.5	5.5	7.1	9.4	12.7	16.8	134.3	-	-
	(220)	-	-	c	66	55	57	51	39	32	29	26	38	34	50	62	94	204	171
14	Muntok	63	-	a	416	267	312	247	182	128	103	111	107	189	306	495	2863	-	-
	Bangka	-	-	b	16.9	12.0	15.2	14.6	10.9	8.5	7.2	6.8	6.2	11.6	16.0	20.0	145.9	-	-
	(251)	-	-	c	98	70	72	61	54	47	40	43	48	52	68	94	131	250	221
15	Manggar	62	-	a	300	191	268	226	253	205	168	128	102	166	245	348	2592	-	-
	Billiton	-	-	b	18.7	12.3	16.2	15.0	15.3	11.7	9.0	6.7	5.8	11.2	16.4	21.0	159.3	-	-
	(265)	-	-	c	60	50	57	53	66	68	57	47	43	48	53	64	118	249	213
16	Pontianak	63	10	a	277	208	242	278	282	222	164	204	228	365	388	322	3180	-	-
	W. Kalimantan	-	-	b	16.6	12.5	14.6	16.4	15.9	13.0	10.1	11.9	13.3	19.1	20.7	18.8	182.9	-	-
	(273)	-	-	c	67	59	65	62	67	65	55	57	59	74	73	68	120	227	220
17	Sampit	40	-	a	289	262	279	278	234	200	133	111	132	194	244	270	2626	-	-
	S. Kalimantan	-	-	b	15.3	13.2	14.5	13.8	11.2	9.8	7.6	6.7	6.7	9.8	13.4	15.4	137.4	-	-
	(293)	-	-	c	59	67	62	75	64	59	51	37	49	54	60	56	113	182	166
18	Muratewe	59	100	a	312	304	346	326	261	222	138	148	175	238	318	337	3125	-	-
	S. Kalimantan	-	-	b	17.2	15.2	17.2	16.4	14.8	12.5	9.8	9.9	10.7	13.1	17.3	18.6	172.7	-	-
	(297)	-	-	c	73	75	76	73	69	65	49	47	55	72	68	65	121	206	200
19	Bandjarmasin	63	-	a	323	298	302	217	158	143	90	82	100	129	216	311	2369	-	-
	S. Kalimantan	-	-	b	21.9	18.9	19.1	15.0	12.7	11.7	9.0	8.3	8.0	11.0	15.8	20.8	172.2	-	-
	(312)	-	-	c	57	60	63	54	48	41	32	27	40	39	52	58	93	242	133
20	Balikpapan	43	10	a	200	174	231	209	232	193	181	162	140	133	168	207	2230	-	-
	E. Kalimantan	-	-	b	14.0	12.7	14.6	13.3	13.0	12.1	11.1	10.7	8.6	9.4	11.8	14.9	146.2	-	-
	(313)	-	-	c	52	43	59	56	63	54	52	51	52	48	49	53	116	231	194
21	Samarinda	36	0	a	181	149	189	205	181	142	111	97	123	151	200	206	1935	-	-
	E. Kalimantan	-	-	b	13.8	11.6	13.4	15.3	14.6	13.4	10.0	9.3	10.0	12.3	14.5	15.4	153.6	-	-
	(326)	-	-	c	44	42	52	50	47	40	36	34	40	44	50	53	91	172	150

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**Monthly daily maximum, all lines c are average monthly maximum per 24 hours, the annual mean column is average of annual maximum, not obtained from monthly maximums

Continued

TABLE III Continued

No.	Name and location of station	Years of record	Elevation feet	Line	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual mean	Maximum record 24 hours	Second largest record 24 hours
					Mean monthly rainfall (line a), Number rainy days (line b), Max. per 24 hours (line c) Lines a and c given in millimeters 25.4 mm = 1 inch														
22	Bojong	48	1312	a	529	470	402	333	373	349	262	221	188	238	345	478	4188	-	-
	North Sulawesi	-	-	b	22.0	18.0	16.8	15.1	16.6	16.6	13.7	11.4	10.6	12.2	17.0	19.5	190.5	-	-
	(342)*	-	-	c	97	86-	85	79	75	68	61	55	48	58	73	100	150**	341	284
23	Donggala	48	20	a	203	155	147	117	110	133	101	95	69	66	111	147	1454	-	-
	N. Central Sulawesi	-	-	b	10.5	9.0	8.7	7.2	7.4	8.4	7.5	6.6	5.8	5.7	7.8	9.3	93.9	-	-
	(363)	-	-	c	64	50	50	52	47	52	40	40	33	31	44	48	113	252	200
24	Pare-Pare	33	7	a	340	250	230	209	175	88	65	40	48	104	221	363	2133	-	-
	S.W. Sulawesi	-	-	b	12.9	12.0	12.5	11.2	9.9	7.7	5.6	3.7	3.8	6.6	11.0	15.1	112.0	-	-
	(404)	-	-	c	86	67	70	62	60	34	31	20	23	39	68	85	132	235	214
25	Macassar	63	7	a	719	531	425	166	92	68	34	10	13	40	174	590	2868	-	-
	S.W. Sulawesi	-	-	b	24.7	19.9	18.2	10.8	8.2	6.3	3.7	1.7	1.7	4.5	11.6	21.7	133.0	-	-
	(422)	-	-	c	115	98	97	55	38	33	16	6	8	19	53	104	150	260	221
26	Djeneponto	29	-	a	267	159	139	68	81	74	45	10	10	12	43	193	1101	-	-
	S. Sulawesi	-	-	b	12.4	9.0	8.3	5.5	5.8	5.2	3.3	0.9	0.7	1.3	3.3	9.3	65.0	-	-
	(429)	-	-	c	64	57	56	29	32	32	22	7	8	8	19	55	100	200	195
27	Koelawi	26	2390	a	148	157	208	183	242	203	178	182	194	164	205	175	2237	-	-
	Central Sulawesi	-	-	b	12.4	11.7	13.7	16.7	16.3	15.9	13.3	13.5	13.8	12.7	14.5	12.0	166.3	-	-
	(387)	-	-	c	38	43	48	53	46	40	43	41	40	42	50	45	76	111	96
28	Kendari	33	33	a	182	170	198	181	207	194	120	62	29	17	69	171	1600	-	-
	S.E. Sulawesi	-	-	b	13.9	12.2	13.3	11.9	13.4	122	8.0	6.6	2.7	2.2	6.1	11.7	125.2	-	-
	(373)	-	-	c	42	50	49	50	52	52	42	20	12	8	26	50	93	206	144
29	Namlea	27	-	a	198	180	197	126	126	126	105	65	40	36	54	135	1388	-	-
	Namlea - Moluccas	-	-	b	11.3	10.0	10.8	8.3	7.6	7.1	5.7	3.3	3.0	2.8	4.0	8.6	82.5	-	-
	(494)	-	-	c	56	57	62	38	42	5;	39	27	17	15	23	45	104	170	159
30	Tobalo	34	-	a	172	179	200	221	236	226	181	129	144	141	160	152	2121	-	-
	N. Halmahera	-	-	b	12.4	12.1	13.1	13.9	16.0	14.5	11.6	9.9	9.7	10.9	12.6	12.1	148.8	-	-
	(498)	-	-	c	48	47	50	49	52	51	40	41	38	38	42	43	87	179	108
31	Sakata	20	3	a	111	104	167	145	137	201	170	118	103	69	69	91	1485	-	-
	S. Halmahera	-	-	b	7.8	7.4	9.5	9.1	11.3	11.4	9.2	8.2	7.4	5.1	5.3	7.4	99.1	-	-
	(498f)	-	-	c	32	37	57	35	27	42	41	26	30	18	23	21	81	203	102
32	Piroe	28	23	a	343	377	322	296	232	188	225	136	115	134	155	240	2763	-	-
	W. Ceram	-	-	b	15.6	14.1	13.0	13.2	11.3	8.9	6.9	8.6	8.4	8.7	12.0	134.8	255.5	-	-
	(488)	-	-	c	64	79	71	69	49	40	55	41	30	30	42	53	117	283	250

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Continued

TABLE III Continued

No.	Name and location of station	Years of record	Elevation feet	Line	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual mean	Maximum record 24 hours	Second largest record 24 hours
					Mean monthly rainfall (line a), Number rainy days (line b), Max. per 24 hours (line c) Lines a and c given in millimeters 25.4 = 1 inch														
33	Tehoroe	20	0	a	166	176	189	257	556	746	1056	655	336	151	85	149	4522	-	-
	S. Central Ceram	-	-	b	9.6	9.3	10.7	10.8	15.5	17.7	19.3	17.8	11.2	6.6	5.3	9.3	143.1	-	-
	(485b)*	-	-	c	44	50	46	62	118	151	199	118	81	56	29	43	266**	624	486
34	Kajeli	37	-	a	214	210	226	171	169	206	171	123	60	47	78	196	1871	-	-
	Buru	-	-	b	14.9	14.8	15.8	13.3	10.9	11.3	9.6	7.2	5.0	4.6	6.3	14.7	124.4	-	-
	(493)	-	-	c	53	45	53	39	53	64	51	33	23	20	27	43	87	363	274
35	Menes	36	361	a	577	427	468	376	255	190	113	129	143	331	464	595	4068	-	-
	N. West Java	-	-	b	20.5	17.8	18.4	17.1	14.6	11.1	8.8	8.1	9.7	15.6	18.4	20.9	181	-	-
	(5f Bantam)	-	-	c	119	89	97	91	60	55	35	40	40	74	97	111	173	318	304
36	Bajah	26	49	a	401	301	351	270	160	131	62	69	92	227	431	467	2962	-	-
	S. West Java	-	-	b	16.8	12.6	14.9	11.0	7.6	6.0	4.0	4.0	4.6	10.7	16.0	17.0	125.2	-	-
	(46f Bantam)	-	-	c	83	73	70	78	57	52	27	27	34	60	105	90	149	283	236
37	Djakarta Observatory	63	23	a	300	299	210	147	113	96	63	42	66	111	142	204	1793	-	-
	West Java	-	-	b	19.4	18.3	16.3	12.0	9.2	7.7	5.5	4.0	5.7	8.8	12.6	15.8	135.3	-	-
	(27) Formerly Batavia		-	c	65	70	54	48	43	38	30	21	29	41	42	54	109	286	195
38	Bogor (Formerly	63	995	a	422	391	393	408	364	268	237	239	322	435	394	357	4230	-	-
	West Java Buitenzorg)	-	-	b	22.6	22.1	23.0	20.4	16.7	13.3	11.3	11.4	13.8	18.5	20.5	21.5	216.1	-	-
	(46f Batavia)	-	-	c	75	68	70	78	82	70	70	66	84	84	74	65	133	260	220
39	Bandung	63	2345	a	202	187	252	225	145	92	60	55	82	166	238	245	1949	-	-
	West Java	-	-	b	16.1	15.2	17.3	15.7	10.7	8.1	5.2	4.5	6.3	11.4	16.3	17.0	143.8	-	-
	(162-Preanger)	-	-	c	43	42	55	51	40	29	25	24	30	41	46	50	81	172	130
40	Pakumbahan	11	104	a	449	370	391	284	198	131	182	27	97	113	323	354	2839	-	-
	N. Central Java	-	-	b	20.8	18.3	17.8	15.9	9.9	7.0	6.5	3.3	5.0	7.8	17.1	18.5	147.9	-	-
	(20-Cheribon)	-	-	c	80	77	103	61	56	37	39	14	42	34	64	69	114	167	163
41	Bodjong	47	2263	a	710	711	543	402	264	154	112	63	90	183	306	475	4013	-	-
	N. Central Java	-	-	b	23.7	22.9	22.8	19.7	14.9	10.1	7.0	4.7	6.3	13.2	18.6	22.0	185.9	-	-
	(60-Pekalongan)	-	-	c	119	127	86	82	57	48	36	24	32	41	63	87	166	319	285
42	Kebokura	31	56	a	337	292	316	251	203	168	84	79	101	375	373	402	2981	-	-
	S. Central Java	-	-	b	20.4	17.9	19.1	16.6	12.2	9.4	7.0	5.7	8.4	15.7	19.5	20.7	172.6	-	-
	(50-Banjumas)	-	-	c	79	61	63	61	68	52	28	32	30	94	83	83	138	232	218
43	Kedung Kebo	63	219	a	399	335	363	256	141	115	49	32	52	183	315	421	2661	-	-
	S. Central Java	-	-	b	20.8	18.9	19.3	14.6	10.2	7.4	4.6	3.5	4.6	10.3	16.3	21.3	151.8	-	-
	(55-Kedu)	-	-	c	86	67	72	66	42	42	21	15	24	61	76	81	134	250	247

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**Monthly daily maximum, all lines c are average monthly maximum per 24 hours, the annual mean column is average of annual maximum, not obtained from monthly maximums

Continued

TABLE III Continued

No.	Name and location of station	Years of record	Elevation feet	Line	Mean monthly rainfall (line a), Number rainy days (line b), Max. per 24 hours (line c) Lines a and c given in millimeters 25.4 = 1 inch Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual mean	Maximum record 24 hours	Second largest record 24 hours
44	Djogjakarta	63	361	a	353	335	311	210	126	88	41	24	31	94	229	340	2181	-	-
	S. Central Java	-	-	b	18.0	17.3	16.6	12.2	8.1	6.0	3.3	2.6	2.6	6.6	12.9	18.2	124.4	-	-
	(53-Djogjakarta)	-	-	c	77	75	71	56	45	31	19	10	16	35	59	76	122	320	256
45	Surakarta (Solo)	63	341	a	332	330	304	212	137	93	49	43	47	112	223	262	2144	-	-
	Central Java	-	-	b	17.7	17.2	17.1	12.0	8.0	5.4	3.0	2.9	3.3	7.7	12.9	15.5	122.7	-	-
	(104-Surakarta)	-	-	c	71	71	65	58	50	40	26	20	24	37	56	64	106	185	190
46	Semarang	5	7	a	254	344	253	182	144	108	87	59	60	137	165	254	2057	-	-
	N. Central Java	-	-	b	20.3	19.3	18.2	15.4	10.4	8.2	5.0	4.6	4.6	10.4	13.8	20.0	150.2	-	-
	(49a-Semarang)	-	-	c	47	80	75	50	71	40	46	24	30	50	50	64	111	145	121
47	Tuban	63	0	a	256	216	199	119	90	64	30	19	19	52	105	204	1373	-	-
	N. Central Java	-	-	b	15.5	13.4	12.7	8.6	6.3	4.4	2.5	1.6	1.5	3.3	7.3	13.4	90.5	-	-
	(56-Rembang)	-	-	c	58	53	51	41	36	29	15	13	11	24	38	50	89	193	162
48	Modjokerto	62	82	a	330	344	330	176	98	66	27	11	17	43	130	259	1831	-	-
	E. Central Java	-	-	b	18.0	17.3	16.7	10.3	6.3	4.5	2.0	1.0	1.1	2.6	7.6	14.4	101.8	-	-
	(95-Soerabaja)	-	-	c	61	66	68	54	38	28	14	7	11	24	51	60	102	205	195
49	Madiun	63	216	a	303	277	265	223	129	80	34	21	30	73	193	259	1887	-	-
	E. Central Java	-	-	b	18.0	16.6	16.7	12.5	8.3	5.0	2.3	1.6	1.8	5.2	12.1	16.0	116.1	-	-
	(37-Madiun)	-	-	c	87	64	63	64	40	34	16	12	17	27	52	63	101	280	239
50	Pakoentjen	30	272	a	293	333	292	197	135	78	37	17	20	94	183	280	1959	-	-
	S. Central Java	-	-	b	13.4	13.4	13.3	7.8	5.3	2.8	1.6	0.9	0.8	3.5	7.6	11.0	81.4	-	-
	(32-Kediri)	-	-	c	60	72	59	56	46	34	22	8	10	32	57	72	109	170	149
51	Probolinggo	63	33	a	234	233	191	105	75	51	16	6	5	13	58	160	1147	-	-
	N.E. Java	-	-	b	14.2	13.3	11.4	6.9	5.1	3.5	1.3	0.6	0.4	1.3	4.5	11.6	74.1	-	-
	(169-Pasuruan)	-	-	c	59	60	57	43	31	25	11	4	4	8	26	51	100	276	250
52	Lumadjing	62	171	a	290	262	277	184	108	96	56	39	34	121	258	304	2029	-	-
	S.E. Java	-	-	b	16.3	15.3	16.1	10.7	7.0	5.7	3.7	3.1	3.2	7.5	14.2	16.1	118.9	-	-
	(185-Pasuruan)	-	-	c	69	63	66	54	36	38	22	21	16	36	64	73	117	225	206
53	Asem Bagus	47	131	a	205	168	143	70	54	37	20	2	3	8	41	135	886	-	-
	N.E. Java	-	-	b	15.5	13.6	11.4	6.6	4.4	3.1	1.4	0.4	0.3	0.8	3.6	11.3	72.4	-	-
	(130-Besuki)	-	-	c	56	50	44	27	25	18	11	2	3	4	22	39	86	173	159
54	Banjuwangi	63	16	a	220	167	155	87	84	91	63	63	45	67	83	160	1285	-	-
	East Java	-	-	b	13.4	12.1	11.4	7.2	7.0	6.2	5.2	5.2	3.9	5.2	6.9	11.0	94.7	-	-
	(186-Besuki)	-	-	c	57	48	47	37	34	35	27	30	22	30	31	48	99	252	251

*Numbers of stations are numbers used in source reference

**Monthly daily maximum, all lines c are average monthly maximum per 24 hours, the annual mean column is average of annual maximum, not obtained from monthly maximums

Continued

TABLE III Continued

No.	Name and location of station	Years of record	Elevation feet	Line	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual mean	Maximum record 24 hours	Second largest record 24 hours
					Mean monthly rainfall (line a), Number rainy days (line b), Max. per 24 hours (line c) Lines a and c given in millimeters 25.4 mm = 1 inch														
55	Mrawan	30	±1312	a	416	337	338	218	113	64	30	28	29	109	236	381	2299	-	-
	S.E. Java	-	-	b	18.0	15.7	17.3	11.6	7.9	5.2	2.8	2.4	2.4	6.9	13.3	17.2	120.7	-	-
	(113-Besuki)*	-	-	c	80	73	70	55	40	24	17	11	15	39	48	80	111**	185	167
56	Kamal	25	16	a	285	226	218	170	93	51	16	11	6	48	146	228	1498	-	-
	S.W. Madura	-	-	b	16.0	13.4	13.0	9.3	6.8	3.8	1.1	0.9	0.4	3.1	7.2	12.8	87.8	-	-
	(3-Madura)	-	-	c	68	54	53	53	33	23	8	7	4	23	44	52	95	180	150
57	Sampang	32	16	a	259	204	216	162	89	54	26	10	8	40	103	228	1399	-	-
	S. Central Madura	-	-	b	14.5	13.0	12.8	9.1	5.8	3.6	1.7	0.7	0.7	2.4	6.4	12.8	83.5	-	-
	(14-Madura)	-	-	c	67	52	52	44	30	22	13	8	5	16	34	52	89	240	124
58	Biratengah	7	±13	a	483	172	150	161	81	34	29	12	0	17	90	159	1391	-	-
	N. Central Madura	-	-	b	16.7	9.7	9.1	7.8	4.8	2.8	1.9	0.9	0	1.5	6.1	10.3	71.6	-	-
	(9a-Madura)	-	-	c	105	55	54	56	32	19	12	7	0	13	34	52	106	296	114
59	Djepun	30	±65	a	308	272	264	213	112	86	23	9	21	32	148	234	1722	-	-
	E. Central Madura	-	-	b	17.0	14.5	15.5	12.3	8.5	5.9	2.0	1.2	0.7	2.1	8.2	14.4	102.3	-	-
	(21-Madura)	-	-	c	68	68	62	56	33	39	13	6	16	13	49	48	109	280	200
60	Negara	58	26	a	226	197	192	131	95	92	57	70	63	151	181	216	1671	-	-
	West Bali	-	-	b	13.3	12.3	12.2	7.9	6.1	5.1	4.2	4.6	4.5	7.7	10.3	12.4	100.6	-	-
	(437)	-	-	c	58	55	51	48	37	41	22	31	31	56	61	57	116	248	165
61	Doeda	9	1712	a	423	294	291	252	353	272	413	182	184	295	353	293	2605	-	-
	East Bali	-	-	b	20.5	14.9	14.6	14.8	14.9	15.8	15.8	10.7	11.2	13.9	14.8	15.2	177.1	-	-
	(444d)	-	-	c	85	74	68	66	114	77	125	69	65	94	86	62	200	327	323
62	Karangasen	33	344	a	248	223	167	81	87	94	83	40	30	76	88	166	1383	-	-
	East Bali	-	-	b	12.1	11.1	10.7	6.3	6.3	5.9	4.5	2.8	2.6	4.7	5.9	9.3	82.3	-	-
	(442)	-	-	c	64	65	48	34	40	41	25	19	14	35	36	69	96	161	152
63	Den Pasar	35	131	a	335	243	205	91	82	72	57	52	35	111	158	296	1737	-	-
	S. Central Bali	-	-	b	15.6	12.8	10.1	5.8	5.1	4.9	4.1	3.1	2.5	5.4	8.1	12.9	90.7	-	-
	(445)	-	-	c	79	58	54	38	42	36	23	23	20	46	54	69	115	292	245
64	Kopang	25	1164	a	260	214	198	117	67	55	53	47	25	94	193	290	1613	-	-
	Lombok	-	-	b	16.0	13.1	11.8	7.0	4.8	4.3	3.0	2.3	2.1	4.9	9.2	15.5	94.0	-	-
	(450)	-	-	c	55	49	51	43	24	22	22	23	12	41	55	55	94	2.66	1.88
65	Taliwang	24	49	a	199	161	171	119	62	35	20	19	19	78	188	229	1324	-	-
	W. Sumbawa	-	-	b	11.0	10.3	11.6	7.8	4.6	3.0	1.4	1.6	1.6	5.3	11.9	13.8	83.9	-	-
	(454)	-	-	c	54	44	46	41	26	18	11	11	10	27	40	52	84	141	131

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**Monthly daily maximum, all lines c are average monthly maximum per 24 hours, the annual mean column is average of annual maximum, not obtained from monthly maximums

Continued

TABLE III Continued

No.	Name and location of station	Years of record	Elevation feet	Line	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual mean	Maximum record 24 hours	Second largest record 24 hours
					Mean monthly rainfall (line a), Number rainy days (line b), Max. per 24 hours (line c) Lines a and c given in millimeters 25.4 mm = 1 inch														
66	Sumbawa Besar	32	66	a	276	229	254	107	50	34	15	9	12	42	121	226	1407	-	-
	N. Central Sumbawa	-	-	b	14.4	12.6	12.5	6.4	3.1	1.9	0.9	0.6	1.0	2.8	7.7	13.1	146.3	-	-
	(455)*	-	-	c	66	58	62	39	28	18	9	7	8	19	43	55	94**	144	125
67	Dompo	15	164	a	192	174	211	140	33	44	32	7	26	69	148	278	1354	-	-
	E. Sumbawa	-	-	b	11.4	10.9	10.4	6.1	2.5	2.3	1.1	0.3	1.8	4.5	8.0	14.6	73.9	-	-
	(4566)	-	-	c	45	42	43	39	18	16	16	4	10	20	43	54	68	96	88
68	Bima	61	0	a	223	203	189	141	61	40	17	12	13	40	127	220	1286	-	-
	E. Sumbawa	-	-	b	15.3	14.3	13.0	8.5	5.0	3.3	1.6	1.0	1.4	4.0	9.5	14.7	91.6	-	-
	(456)	-	-	c	48	45	48	46	27	18	9	8	7	15	39	49	79	219	174
69	Labuan Badjo	24	3	a	176	164	123	70	49	35	16	6	14	29	58	196	936	-	-
	W. Flores	-	-	b	10.4	10.2	7.4	4.6	3.0	2.1	1.4	0.8	1.2	2.9	5.1	11.0	60.1	-	-
	(463a)	-	-	c	54	46	43	36	19	19	9	4	9	13	23	53	80	200	122
70	Badjawa	31	4100	a	366	345	320	172	97	47	55	25	14	37	147	334	1945	-	-
	W. Central Flores	-	-	b	19.0	16.8	15.9	9.8	6.3	4.2	4.1	1.7	1.7	3.5	9.2	16.2	108.4	-	-
	(465)	-	-	c	69	69	67	54	37	21	16	13	8	16	46	61	121	276	184
71	Ende	31	0	a	191	149	155	94	57	42	47	14	33	75	123	158	1138	-	-
	S. Central Flores	-	-	b	12.4	11.7	1.6	6.7	5.6	5.0	4.3	2.4	3.1	5.5	7.4	11.6	87.3	-	-
	(466)	-	-	c	67	42	45	43	24	17	22	6	21	35	47	48	106	304	208
72	Maumere	37	0	a	178	166	144	89	45	28	18	7	7	27	78	167	954	-	-
	N. Central Flores	-	-	b	12.3	10.8	9.9	5.5	3.2	1.9	1.3	0.8	0.7	2.2	5.6	10.1	64.3	-	-
	(467)	-	-	c	51	52	48	40	21	19	11	5	4	17	29	51	99	259	158
73	Larantuka	37	-	a	249	219	199	102	44	34	18	6	5	32	99	169	1176	-	-
	E. Flores	-	-	b	14.6	13.0	11.9	6.5	3.3	2.5	1.6	0.8	0.8	2.9	8.0	13.0	60.0	-	-
	(468)	-	-	c	57	65	63	42	22	18	12	4	3	15	38	47	105	295	188
74	Wai Kabubak	30	1181	a	298	292	317	156	98	51	33	33	37	59	201	320	1895	-	-
	W. Sumba	-	-	b	16.8	16.8	17.0	9.8	6.1	3.0	3.0	2.3	2.7	5.2	11.7	16.3	110.7	-	-
	(460)	-	-	c	62	62	69	43	37	18	13	17	18	22	46	64	105	210	170
75	Lewa	6	1624	a	238	332	354	159	127	91	54	18	0	57	241	313	1984	-	-
	Central Sumba	-	-	b	20.0	19.7	17.0	8.2	5.5	5.5	3.8	1.4	0.0	4.5	12.8	20.3	118.7	-	-
	(460C)	-	-	c	55	70	79	62	60	40	22	15	0	27	71	54	113	152	130

*Numbers of stations are numbers used in source reference

**Monthly daily maximum, all lines c are average monthly maximum per 24 hours, the annual mean column is average of annual maximum, not obtained from monthly maximums

Continued

TABLE III Continued

No.	Name and location of station	Years of record	Elevation feet	Line	Mean monthly rainfall (line a), Number rainy days (line b), Max. per 24 hours (line c) Lines a and c given in millimeters 25.4 = 1 inch												Annual mean	Maximum record 24 hours	Second largest record 24 hours
					Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.			
76	Melolo	30	0	a	154	154	165	86	39	36	18	9	2	8	34	112	817	-	-
	E. Sumba	-	-	b	11.1	9.4	10.8	5.6	3.1	2.7	2.1	0.8	0.2	0.3	2.7	8.0	56.8	-	-
	(462)*	-	-	c	44	46	44	32	20	17	9	6	2	7	16	39	72**	146	140
77	Kupang	63	7	a	386	347	234	65	30	10	5	2	2	17	83	232	1413	-	-
	W. Timor	-	-	b	18.1	15.5	13.2	5.0	2.5	1.2	0.8	0.3	0.3	1.3	6.9	14.7	79.8	-	-
	(470)	-	-	c	90	91	63	30	13	8	4	2	2	10	34	59	124	197	190
78	Niki-Niki-	12	2198	a	253	283	231	114	108	63	42	12	3	33	87	325	1464	-	-
	S. Central Timor	-	-	b	16.5	17.6	16.7	8.4	11.5	8.0	4.7	1.8	1.0	1.2	5.8	15.2	109.4	-	-
	(471)	-	-	c	63	58	52	55	37	23	24	7	3	17	29	58	113	330	133

*Numbers of stations are numbers used in source reference

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in Indonesia[1] was based partially upon their geographical distribution (Fig. 12) and partially upon their proximity to areas that will be discussed later in some detail relative to particular agricultural engineering problems.

In the section of his treatise on equatorial soils devoted to classifications of equatorial climates Mohr[2] states that methods of classification developed by Köppen and other climatologists are not applicable to the Indonesian Archipelago and suggests a method based upon rainfall that establishes five classifications with two subclassifications. The controlling factors in this system are monthly evaporation and precipitation rates. From experimental studies at Bogor Mohr reported that evaporation rates vary between 2.56 inches in dry months and 3.35 inches per month during wet months. He then considered any month with less than 2.37 inches rainfall as dry months and those with more than 3.94 inches wet months. Those months with precipitation between 2.37 and 3.94 inches were considered as fringe months with their influence upon the soil forming processes and vegetation determined by the antecedent moisture content at the first of the month and the intensity of rainfall in the ensuing month.

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1. H. P. Berlage, Jr., Regenval in Indonesia (Rainfall in Indonesia), Verhandelingen No. 37, Dept. van Verkeer, Energie and Mijnwezen Meteorologische en Geophysiche Dienst Koninklijk en Meteorologisch Observatorium, 1949.
2. Mohr, op. cit., pp. 55-60.

The figure groups considered by Mohr are outlined below:

Group I. Continuously moist or wet with no single month having rainfall less than the minimum evaporation rate of 2.37 inches per month. This is further divided into those (I-a) with no single monthly average above 5.90 to 7.87 inches and those (I-b) with no single monthly average below 7.87 to 11.82 inches.

Group II. Climates with no more than one dry month (less than 2.37 inches rainfall).

Group III. Climates with a distinct dry season of two to three months.

Group IV. Climates with a distinct dry season of four to five months.

Group V. Climates with a distinct dry season of six to eight months.

Analysis of data from 2,492 stations on Java and Madura permitted Mohr to prepare a climatological map for these islands, which located almost all areas under Groups I-A, I-b, and II to be in the western half of Java. All areas in Groups III, IV, and V are in East Jave and Madura. Narrow coastal fringes on Madura are identified as Group IV with approximately two-thirds of the island astride its longitudinal axis classified as Group III.

Almost all of Sumatra has rainfall that falls under

Groups I and II, with Group II predominating south of the line from Palembang to Bengkulen and in the Batak highlands between Padang and Medan. The Achin area of North Sumatra falls into Group III because of the influence of the dry winds from the Asian Continent.

The Riouw Archipelago, Bangka, Billiton, and Kalimantan are almost exclusively in Groups I-A and I-b, with the exception of a small area east of Bandjermasin. This small area shows the influence of the dry east monsoon that has such a strong effect on the Lesser Sunda Islands, East Java, and Sulawesi. Sulawesi, approximately midway between Australia and Asia, has alternating wet and dry seasons with considerable local variations that place most of it in Groups III, IV, and V.

The Lesser Sunda Islands are affected so strongly by the dry east monsoon that virtually no areas may be classified as Group I, a few small areas as Group II, some areas as Group III, and most of the areas as Groups IV and V, with Group V predominating in the eastern islands. The information available from rather widely separated locations indicate that Groups I and II are the dominant groups in the Moluccas and in Irian.

The topography and precipitation of Indonesia are reflected in its rivers, which typically are narrow with a steep gradient in their upper reaches and wide and shallow as they approach the coastal areas. Only three

Indonesian rivers are navigable to any extent, the Musi in South Sumatra with sea-going vessels able to sail inland about sixty miles to Palembang, the Barito in South Kalimantan which is navigable inland for about one hundred and fifty miles, and the Mahakam in East Kalimantan which is navigable inland about one hundred miles.

Because almost all of the rivers have their headwaters in steep mountainous areas and originate in relatively small watersheds, they reflect heavy rainfall in flood crests very quickly and transport large boulders to their flatter slopes causing much damage to bridges. Hardly a week passes during which at least one flood is not reported in the newspapers. It is characteristic that the areas damaged by floods are usually a few acres and seldom as much as a thousand acres; however, many bridges are destroyed annually and the total damage to crops amounts to several million dollars.

Because the streams originate in mountainous areas, many of which are covered with highly erodible volcanic ash, the silt loads of the streams are extremely heavy. Where it is possible to irrigate rice with the silt-laden water, it is considered very desirable because of the fertility of the ash which contains magnesium, potassium, and phosphorus as well as other minerals. This concept is so strong that clear water either from streams or wells is generally considered unsatisfactory for irrigation purposes in spite of the detrimental effect of silts originating in marly formations on the soil structure and upon the availability of phosphate. The heavy silt load also contributes to the deposition of natural levees along the streams; therefore, over a period of time the stream beds tend to rise above the level of the adjacent coastal plains and increase the danger of floods and changing stream courses. In some swampy areas where rivers are interconnected, as in South Kalimantan and Southeast Sumatra, these levees have developed large lakes which are dried only by evaporation near the end of the east monsoon. In the latter area this has led to a peculiar type of farming known locally as the lebak culture which will be discussed later.

The natural levees, together with tidal action in the vicinity of Kuala Kapuas in South Kalimantan and in the vicinity of Palembang in Southeast Sumatra, result in a hydrologic oddity affecting large areas. At Kuala Kapuas the difference between high and low tide is almost ten feet and at Palembang slightly more than six feet. At high tide the flow of the large interconnected rivers is blocked by the rising tide, with the result that the crest becomes higher than the natural levees and fills the basins enclosed by the levees between the confluences of the streams. As the tide recedes and the normal flow of the streams is again towards the coast, the crests fall below the levels of the basins, but the water is retained in the basins for lack

of open drainage canals. Near the coastal areas there are various degrees of brackish water, but this effect does not reach very far inland. The discharge of the rivers is so large that the water filling the basins, except very near the coast, is the fresh backwater of the rivers. Large areas along Sumatra's east coast and in South Kalimantan which are potentially good agricultural areas have caused the Indonesian government to undertake the development of polder development in the Kalimantan area to determine the feasibility of controlled drainage and irrigation through the use of levees, control gates, and pumps. The term polder has been added to the Indonesian language, at least on the island of Kalimantan, if not throughout the Archipelago, largely because of efforts of Ir. Dr. H. J. Schopuys, Chief of the Agricultural Extension Service of Kalimantan until December 1952, who has prepared extensive general plans for the reclamation of more than a million acreas of lowlands in South Kalimantan. The term polder refers to an area protected from high waters by levees. The drainage of polders is accomplished by the use of one-way valves or pumps and sometimes by the use of both.

Because of _ladang_ agriculture's tremendous influence upon the present vegetation of Indonesia, a description of this culture should preface any description of vegetation for the benefit of the reader who is unfamiliar with primitive agriculture in tropical regions. As it is used

in Indonesia the term _ladang_ agriculture is used to describe a semi-nomadic type of farming carried on by the people of the sparsely populated areas with a minimum of tools and power, other than human, at their disposal. Under _ladang_ culture the farmer cuts the trees or brush of an area and when the vegetation has dried sufficiently, it is burned. Because of the farmers' inability to control the fire large areas of forest and formerly cultivated fields are also burned. After burning, the fields are interplanted with corn, rice, or both among the stumps and logs with little or no further preparation (Fig. 13). The fields remain under cultivation for two or three years and are then left for native vegetation to return; however, the vegetation that is often best able to compete with the repeated burnings is alang-alang grass (_Imperata cylindrica_ P.B.), and the result has been that vast areas once covered with forest are now savanna (Fig. 14). _Ladang_ culture is so widespread that it is difficult to say whether the native vegetation in many areas was once forest or whether because of soil and climatic conditions it has always been savanna. Because of a lack of forest lands, especially in the Lesser Sunda Islands and in some areas of Sumatra, the burning of _alang-alang_ fields as partial preparation for planting rice and corn is quite common. The _ladang_ amounts to a primitive rotation with land in crops two to three years and in grass or second growth forest for four to ten years. The time

Figure 13. Land cleared by the ladang method Photo courtesy Ministry of Information, Djakarta.

Figure 14. Alang-alang following ladang culture on South Kalimantan

land remains in forest depends upon the population density and the need for land for food crops.

General references to Indonesian soils usually make the broad statement that because of their volcanic origin they are very fertile. In the highly developed agricultural areas of Java, Bali, Lombok, and some parts of Sumatra the general statement is well founded, but it is also misleading when one is thinking of the agricultural potential of the entire country. The population distribution of Indonesia largely reflects the productivity of the soil under its local climatic conditions, and observations about the national potential based upon the densely populated areas are comparable to the accuracy of such an estimate of the productivity of the United States after an inspection of only the corn belt. Such observations are often made by visitors after brief visits to Java, Bali, or parts of Sumatra, while soil scientists who have made more detailed studies even make a sharp differentiation between the potential of areas according to whether the volcanic influence is geologically recent or not, as well as other characteristics not readily discerned in casual observation. The soils developed by the soil forming processes from recent volcanic ash are fertile and have good structure, while those from old volcanic ash are infertile as the result of excessive weathering.

In view of the vast differences in the characteristics of the Archipelago, some of the principal characteristics of topography and soils will be given. These incomplete descriptions are based upon available literature in English and observations of the author on numerous field trips. The observations recorded here are necessarily superficial because most of the literature is in the Dutch language and also because the study of soils was in no case the primary purpose of the field trips. A field trip to the islands of Flores, Sumba, and Sumbawa was in the company of a soils scientist; therefore, the description of parts of these islands may be more detailed than their agricultural importance justifies.

It is characteristic of all the islands of Indonesia, with the exception of Kalimantan, that along their longitudinal axes are ranges of mountains. The areas of highest rainfall are in the mountains where the rivers receive their heavy load of fertile silt for deposition either in the irrigated fields, the alluvial coastal plains, or the coastal swamps. There are few rivers that do not approximately parallel the transverse axes of the islands; therefore, the rivers are generally short and have small watersheds. Because the watersheds of the streams are narrow and usually steep in the upper reaches, the intense tropical rains over small areas and of short duration in time are quickly reflected in the floods so often reported in the lowlands. The morphology of the areas volcanic in origin further accelerates the concentration of runoff so that the flood crests attain a miximum very quickly. The lava and subsequent mud flows (lahars) from the volcanoes left a gently sloping to steep mass of easily erodible material at the base of the volcanoes which was quickly dissected by erosion so that contours around the numerous noses protruding from the mountains have the shape of the flattened edge of giant morning glory blooms. Because of the numerous indentations in the topography, runoff from any point quickly reaches a channel with the accelerated flow common to channel flow as compared with the shallow flow over large areas.

Kalimantan is the exception to the general pattern of long narrow islands and also is exceptional in its lack of volcanic mountains. It does conform in that its highlands are in the central area; however, its topography is such that its general drainage pattern may be described as being radial. While floods are also common in Kalimantan, they are the result of the sustained rains of the wet monsoon in the areas of the interior and are normally of much longer duration than the floods that occur on the other islands.

B. Particular Characteristics of Java

It is only natural that, because approximately two-thirds of the Indonesian population is concentrated on the island of Java, because it was the island of principal economic importance in the Netherlands East Indies, and because seventy-seven percent of its land area has been cleared for cultivated crops, there is more detailed information available relative to its soils as well as in every other respect than is available for the remainder of the country. Reconnaissance soil surveys have been made for all of Java and detailed soil surveys (scale 1/50,000) have been completed for large areas by the Institute for Soil Research of the General Agricultural Experiment Station at Bogor. The mapping procedure according to Dames[1] has been based upon field discernable characteristics of the soil profiles which permitted grouping soil species under related soil types. The soil type compares with the series designation, while the species compares with the differentiation within series which is commonly used in the United States.

According to Dames, as well as other soil scientists, virtually nowhere in Java has the soil developed from a single parent material, but everywhere there is the combined influence of volcanic activity and of aeolian or aqueous sedimentation. Soils maps have been prepared based upon the field surveys supported by essential mineralogical, physical, and chemical investigations to establish the

1. T. W. G. Dames, Some Notes on the Soil Survey of Java, Reprint from Commonwealth Bureau of Soil Sci. Tech. Communication No. 46, 1949, 6 pp.

pedalogic characteristics of the various soils. The importance and extent of soils information already collected is indicated by the existence of approximately 2.5 million acres in Java known to be deficient in phosphate where the application of moderate amounts (100 to 200 lbs. per acre) of double superphosphate will increase rice yields from ten to fifty percent.

The climate of Java is hot and humid, and with the exception of the cooler areas in the mountains the experience of the Institute for Soil Research has indicated that differences in the soils are primarily due to differences in the parent materials and the topography rather than in the minor climate variations. In the earlier reference (pp. 89-91) to Mohr's classification based upon amount and distribution of rainfall, it is evident that the soils of Java have developed under continuous leaching, although perhaps intermittent leaching with minor exceptions. The Institute has distinguished ten main soil groups (series) which are briefly described below.

(1). The volcanic ash-soils consist of unweathered or slightly weathered, clastic, andesitic, or basaltic materials. Ash includes all loose volcanic products such as dust, sand, gravel, and stones. As soil profiles have not developed over these materials, the most important property other than mineralogical is texture so that this type is subdivided into ash-gravel, ash-sand, ash-dust, and ash-loam with further description as young, grey; slightly weathered, older, light yellow; or light brown ash soils. Chemically these soils are fertile except in nitrogen and are slightly acid to neutral. Green manure crops are always beneficial to these soils, and the coarse sands or gravels also need chemical fertilizer. The fine sands and loams constitute some of Java's most fertile soils. Hardpans are quite common just below the surface of this type of soils, but are generally beneficial in that they reduce the water lost through percolation in both irrigated and rain dependent sawah but such hardpans are detrimental to sugar cane, tobacco, and non-irrigated crops.

(2). The lateritic soils are the brown and red soils that from the standpoint of area are the most important type of Java. These soils are primarily developed over the andesitic and basaltic deposits from the volcanic activity of the Pliocene and the Quaternary Ages, but some dacitic and leucitic material is also present. Over the older volcanic materials there are also some lateritic soils, such as the tuff sandstones and breccias and other tuffs rich in basic materials. The brown and red lateritic soils have normally developed under good drainage conditions and the older the soil the more reddish the color if environmental conditions, are equal. Often from a distance these soils appear to be red but upon close examination are either

reddish brown or a pure brown. In young brown soils concretions are usually absent, but small yellowish-brown lateritic concretions may occur dispersed, and sometimes they form a true concretionary horizon. Such a horizon is by no means characteristic for this soil group and owes its formation to local internal drainage conditions. In the younger brown soils considerable mineral reserves are present, while in the old red lateritic soils no mineral reserves are present.

In the young, brown soils, because of impregnation of soil particles with iron hydroxide, some granulation has occurred so that the sand fraction is usually 20 to 30 percent; however, the older the soil the larger the amount of the clay fraction. The old red lateritic soils usually have more than 70 percent clay and less than 5 percent sand. With pedologic age the pH reaction of the soil changes from slightly acid (pH 6.5) to very strongly acid (pH 4.5). The younger soils are rich in available phosphate, potash, lime, and magnesium, but the older soils are deficient in these nutrients. Since the phosphate content of the old lateritic soils is soluble in a 25 percent solution of HCl, it is presumed that the phosphate has reacted with iron or aluminum to form resistant compounds. The lateritic soils have good physical properties with favorable conditions of water movement and aeration, show little shrinkage or cracking when dry, and are slightly sticky when wet. Both the young and the old lateritic soils are good agricultural soils, but the older soils require the addition of fertilizers to make them productive.

The chemical analyses of soil at the Institute showed the SiO_2/Al_2O_3 ratio to vary between 2.2 and 2.9 while the SiO_2/Al_2O_3 Fe_2O_3 varied from 1.5 to 1.9. X-ray analysis proved the clay mineral to be kaolinite. The base-exchange capacity ranges from 10 to 20 m.e. per 100 grams. While these soil types are classed as lateritic, true laterite soils have been sporadically found on Java.

(3). The <u>mountain soil type</u>[1] lies between a true podzol and a brown-earth and develops under conditions of high moisture and moderate temperatures where abundant humus accumulation occurs. In this type of soil, as it occurs on Java, there is no distinct differentiation between the eluvial and the illuvial zones, and its most characteristic feature apart from the 10 to 30 percent content of humus in the top soil is the degree of granulation due to the impregnation of the particles with iron hydroxide and humus and to the absence of concretions or hardpans. These soils are extremely to strongly acid (pH 4.0 to 5.5), but under good management are satisfactory for tea, coffee, cinchona, and vegetable crops. The continuous

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1. Dames has recently proposed that this soil type be referred to as the humic brown soils because sometimes they are also found in the coastal plains under specific conditions of parent material, climate, and vegetation.

leaching by water with a high humus content results in a brownish to black topsoil and a yellow-brown subsoil that is subject, after clearing of forest and exposure to the sun and wind, to severe erosion unless due attention is given to the preservation of humus.

(4). The <u>margalite soils</u> are usually black or gray but are sometimes yellow; these soils typically have developed over marls and lime containing shales. They are very heavy, become very sticky when wet, are subject to severe cracking when dry, and contain concretions of iron and manganese throughout the profile. Calcareous concretions occur both in the topsoil and in a white calcareous horizon in the subsoil at a depth of three to five feet. Soils of this type also develop over lime-containing tuffs and are sometimes found over volcanic tuffs. As the lime content of the parent material decreases, there is a decrease in the calcareous concretions which lead to the distinction between the lime-margalites and the tuff-margalites which are weakly acid (pH 6.0 to 6.5). The mechanical analysis of this soil type shows it to be similar to the lateritics in its content of sand, silt, and clay, while chemical analysis shows the SiO_2/Al_2O_3-Fe_2O_3 to always be above 2.5. The clay mineral belongs to the montmorillinite type which explains the difference between this soil and that of the lateritic type.

(5). The <u>limestone soils</u> (<u>terra</u> <u>rossa</u>) occur in the

crystalline-limestone areas which have a karst landscape, and in these areas the soil has developed a reddish-brown surface. The accumulation of aeolian deposits has been an important influence in the development of these soils. There are also some black limestone soils on Java, but these usually occur over earthy limestone materials.

(6). The marsh soils occur in river-flooded areas or near the coast in the presence of a high water table. The topsoil is usually a black or greyish humus loam or clay, while the subsoil is paler in color and shows yellow or brown mottling or streaks. These soils are acid (pH 4.5 to 5.0), sticky when wet, and tending to crack when dry; these characteristics, however, are not as marked as with margalitic types of soils. The chemical properties of the soils vary in accordance with the parent materials, but usually these soils are well adapted to irrigated rice fields.

(7). The quartz soils are a group of soil species that have a large content of particles in the 50-100 micron range and are related to the red-yellow podzolic soils. Typical samples may have a content of ninety percent of quartz silt with traces of zircon and tourmaline, but the single grain structure that occurs in the absence of any clay fraction is the principal characteristic of the type. Differences in the parent material may result in acid lateritic soils or alkaline margalitic soils, both of which are poor in plant nutrients and therefore require heavy fertilization for adequate production levels.

(8). Bleached earth as a soil type occurs in the western part of Java over dacitic tuffs, and here white loams with iron-manganese concretions are found. At various depths there occurs a hardpan with a high content of silica, iron, aluminum, and manganese which in turn overlies a stratum of clay. The soils are strongly bleached by continuous leaching and in some respects resemble podzolization, but it is unlikely that acid humus was present in the leaching process. These acid soils are so poor in plant nutrients that they have little agricultural value and have probably developed as ground-water laterites.

(9). Peat soils of the eutrophic and of the topogeneous types occur in relatively large areas of Java. Polak[1] describes the peat development of the Rawa (marsh) Pening near Semarang, where floating masses of peat soils are secured by bamboo poles and are cultivated in rice. Detailed study of this particular area showed that at one time it was an upland forest, subsequently covered with volcanic materials. These volcanic materials blocked the drainage and thus established a swamp where trembling marshes developed floating grass mats at the edges of the stable islands and land spits. Because of the effects of rising water and wind, the grass mats break off and become

1. B. Polak, Construction and Origin of the Floating Soils of the Rawa Pening (Central Java), Contr. Gen. Agr. Res. Sta. No. 121, Bogor, Indonesia, 1951, 11 pp.

floating masses of peat soils covered with water grasses and sedges and are capable of supporting some agriculture. The influence of rising and falling water levels in breaking off the grass mats was accentuated in 1916 when a dam constructed across the Tuntang River to conserve wet monsoon rainfall for dry monsoon irrigation caused a variation of three to six feet between the annual high and low water levels. The formation of peat soils under the water of alkaline reaction (pH 7.5 to 8.5),is, according to Polak, in contrast to Mohr's opinion that peat soils cannot develop in an alkaline milieu because the bacterial activity would prevent the accumulation of plant material. Polak[1] states that in the tropics topogenous peat is formed when stagnant and not too deep water is present, because it checks aerobic conversion of plant material regardless of the acidity or alkalinity of the water.

(10). <u>Sedimentary soils</u> include all recent river, coastal, and lacustrine deposits where distinct soil profiles have not yet developed and usually where sedimentation is still occurring. Because a large portion of the sediment originates from the volcanic ash deposits of the mountains, these soils, usually productive, are a mixture of the silts, clays, and sometimes the fine sands transported by the rivers at flood stage.

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1. Ibid., p. 10.

C. Particular Characteristics of Sumatra

As previously stated, the mountain chains of Burma extend through Sumatra in the Barisan Mountains, which may be described as the dominant source of all soil forming materials of this island which is the world's fifth largest island. Mohr's already oft-quoted treatise[1] is the primary source of information relative to the soils of Sumatra as virtually no other English literature has been available. Basic information about the geological history, the soils, and climate from the literature is supplemented by comments and illustrations of the author's more than five weeks of travelling over the island at various times.

The Barisan Mountains extend almost the full length of the island in two ridges with scattered intermontane valleys and plateaus that vary in size from a few acres to many thousand acres. The ridges themselves have many high peaks of volcanic origin, a few of which approach 10,000 feet in elevation and are connected by Permacarbonate sedimentary rocks as well as by frequent outcrops of granite intermingled with Pretertiary, Tertiary, and Quaternary rocks, which are often mixed with or overlaid by volcanic efflata of all ages. On Sumatra's northeast coast there is a wide piedmont separated from the coastal swamp by a coastal plain varying

1. Mohr, op. cit., pp. 416-554 passim.

from a few miles to more than a hundred miles in width. At the north in the Achin territory and in the south in the area known as the Lampongs, the Barisan Mountains fade out, the piedmont and the coastal plains extending around both extremities to the west coast. In many areas along the west coast the mountains extend to the Indian Ocean so that the area of arable land west of the mountains is small and agricultural development has been relatively unimportant. The extend of the low-lying lands to the east of the mountains is perhaps most evident in Mohr's[1] estimate that 40 to 60 percent of the island lies at an elevation of less than three hundred meters.

In the Achin territory of North Sumatra, the valleys have developed fertile soils from the sedimentary volcanic materials, while the processes of erosion have exceeded the rate of soil formation in the mountains to such an extent that many of the sloping lands perhaps have never even supported a forest cover. Over most of the mountain lands, rain forest has existed and even in 1933 it was estimated that 62 percent of the area was still in forest. Between the savannas of <u>alang-alang</u> grass and the rain forest, pine (<u>Pinus Merkussi</u>) has grown in large areas and has been protected by the people for its production of resin and turpentine. Under the <u>alang-alang</u> grass black earths have

1. Ibid, p. 316.

developed but usually are not as fertile as the alluvial plains nearer the coast where the population has concentrated its efforts in the production of rice and copra. The coastal plains of Achin have been modified in their topography and usually have been benefitted in their fertility by the lahars from the volcanoes of the area. The northern part of Achin suffers a dry season under the influence of the winds from Asia (Stations 1,2; Table III), and it is in this area that rubber and oil palm have become important. On the sandy river levees in the southwest part of Achin, the pepper (Piper Nigrum) has been most successful. The mangrove swamps have furnished both tannin and firewood for the population.

The Batak Highlands occupy the highlands of the central portion of North Sumatra, and Lake Toba is roughly the center of this area. Granite is the principal type of the older rocks, but characteristically the old rocks within an area of eight thousand square miles around Lake Toba were covered by liparitic tuffs to depths varying from 20 inches to 160 feet either from volcanic action at Lake Toba or nearby. Southwest of the lake, erosion has again uncovered the older rocks and between the lake and Medan, especially in the Karo Plateau, subsequent volcanic action has covered the liparitic tuffs with ash and dacitic material.

The Karo Plateau is a gently rolling, hummocked area at an elevation of 3000 to 3500 feet. It is well dissected by

streams which have cut deep channels in the easily eroded material. Since little water is available for the irrigation of the plateau, most of it is savanna except in the relatively small valleys. Because of the altitude the climate is warm but not hot, and with the high rainfall (Station 3; Table III) the soils developed are usually a sandy or fine sandy loam, reddish-yellow lixivium of medium fertility. Commercial fertilizers have commonly been used in this area for some years in order to obtain satisfactory yields of the vegetables produced for export to Singapore. The high plateau also exists in a more broken form west of Lake Toba towards Sibolga where there is almost a continuous expanse of savanna until the descent to the coast begins west of Turungtun. The valleys and the lake plain are irrigated and as usual the principal crop is rice.

On the west there is an abrupt drop from the plateau to the coast with a very narrow coastal plain where coconuts and rubber share the position of greatest importance with rice. On the steep slopes leading to the coast farmers' rubber occupies a large percentage of the area. The land is cleared with fire and axe for dry rice, which is generally followed by cassava and interplanted with rubber seedlings. After the cassava is harvested, the rubber becomes the principal specie in the second growth forest that returns to cover the slopes which, from a conservation viewpoint, should never have been cleared. Perhaps the reader may be

better able to realize the ruggedness of this terrain if he can visualize the Turungtun-Sibolga gravelled road which has few places wide enough for two cars to meet and which descends about 10,000 feet in a distance of 30 miles. In one five-mile section of this road the author counted one hundred thirty-nine curves -- not the simple elements of compound curves but an average of thirty-eight distinct changes of direction per mile. The reason for this particular observation was the author's inability to understand the local dialect of the pick-up truck chauffeur, to see out of the cut on the high side of the road, to see into the valley on the low side of the road, and to read or make notes because of the roughness of the road.

East of the Batak Highlands the transition from the plateau to the piedmont is also quite steep; however, the main roads on this side of Sumatra are very good. In this area there has been some tea and coffee, but the field crops of Sumatra's East Coast deserve the credit for its agricultural fame.

Sumatra's East Coast is the name usually given to a small part of the northeast coast in the vicinity of Medan. This area first gained its prominence from the peculiar combination of soils, climate, and original type of vegetation which proved to be ideal for the production of the highly regarded Sumatra wrapper tobacco used in cigars. The elevations of the area vary from sea level to 6500 feet,

but most of the area is relatively low. Mohr has classified the soils of the area in six general classifications ranging from variegated infertile loams developed under subaqueous weathering, through better sandy lixivums, reddish in color, which overlie liparitic tuffs, and to the best soils of the area which are the black dust soils developed from the youngest lahars over pale yellow subsoils. The latter type of soil has proven most satisfactory for the wrapper tobacco and because of its success has led to the establishment of many plantations in the vicinity.

This area was sparsely populated at the time the agrarian law was passed in 1870 and many tobacco estates were established. As the production of tobacco on soils other than the black dust soils proved uneconomical, other export crops such as rubber, tea, oil palm, sisal, abaca, and some coconuts were planted. It is perhaps worthy of note at this point to state that the tobacco rotation of this area is one of the oddest rotations in the world, in that the forest is cleared and a crop of tobacco is planted. After the harvest the land is permitted to return to the forest growth to restore the humus condition of the soil to its original condition or as near to such a condition as is economically feasible. The land is again cleared and planted in tobacco after seven to ten years, a sufficient length of time under the existing climatic and soil conditions to develop a second growth forest of considerable density. Only

under conditions of large concessions, cheap labor, and a crop of extremely high value could such a system of culture exist.

The limited scope of the arable lands of Sumatra's west coast was mentioned in connection with the Batak Highlands. The restricted area of land available for cultivation along the west coast extends southward through Bengkulen. The climate of the coastal area is continuously wet (Stations 6,7,8,9,12; Table III), while the intermontane areas usually have a relatively mild dry season of two to three months from July to September. The older rocks of the area are those of the Permocarboniferous block folds apparent in the two ridges of the Barison Mountains and include granite with mica schists and quartzite or clay slates and quartzitic masses in the western ridge or gray limestone in the eastern ridge. In both ridges the rocks are covered to varying depths by breccias, conglomerates, pumice, and other volcanic efflata. The mountains and hills are infertile, but the valleys and the limited alluvial plains are very fertile. As the volcanic material from one period of volcanic actions covers previous deposits before the previous deposits have had any opportunity to weather and develop a soil profile, weathering in the earlier deposits is virtually stopped except for minor leaching which changes the content of silicic acid, and under the overburden consolidation occurs to a minor degree in the

formation of the tuffs. One of the largest and most famous masses of tuff of the country is the Agum tuff in the vicinity of Bukit Tinggi.

The Karabouwengat Canyon (Fig. 15) at Bukit Tingi is the result of geological erosion by the river flowing through it. The semi-consolidated tuff is more subject to erosion than the soils that have devloped over it with their vegetative cover. Undercutting is a continuous product of every flood so that bank caving is a frequent occurrence. Because the minerals of the tuffs have not been subject to continuous leaching through the ages, the deposits of this material in the flood plains of the streams result in a fertile soil. The fertile soils of the valleys and flood plains constitute the principal lands of value in West Sumatra. The mountains are still covered with mixed tropical rain forest which has not been exploited to any appreciable degree because of mixed nature of the forest and the absence of routes of communications. As in the case throughout Indonesia, rice is the most important crop; however, in the vicinity of Bukit Tinggi the production of vegetables receives considerable attention also, and although not of major importance to the country, in particular areas sugar cane is a major local crop. As the areas of arable land are usually adequate only for the needs of the local population, estate agriculture has never attained the importance here that it has on the East Coast.

Figure 15. Karabouwengat canyon in West Central Sumatra

Figure 16. Galam poles used with iron wood in dam construction on Kalimantan

The South Sumatra mountains are a continuation of the conditions prevalent on the west coast to the area of the Lampongs. Much of the area is so steep that no great development of agriculture could be expected even if the mountain soils had developed to a reasonable level of fertility. It is true that in the mountains of Java and Bali the farmers' agriculture has had its greatest advancement, but the development in these areas was under population pressure unknown to Sumatra and with labor so cheap that its cost was negligible, whereas today labor costs thirty to ninety cents per day without the rice that is usually furnished. As has often been stated before about other areas, those soils that have been rejuvenated by young volcanic ash or which because of topography can be irrigated from streams rising in young volcanic areas lend themselves most readily to the rice culture of the farmer. In the South Sumatra Mountain area in the vicinity of the younger volcanoes and at elevations above 2950 feet, some estates have been established primarily for tea and coffee.

The eastern part of the Lampongs and the lowlands of Easternmost and Central Sumatra can be considered as one soils province, in that this area encompassing almost one-half of the total area of Sumatra lies below the elevation of 325 feet. All of the soils of the area are sedimentary with those adjacent to the coast having been deposited first as marine sediments and later having been lifted above the sea level and with the remainder of the area further inland having originated from terrigenous sediments.

The lowland area of Sumatra consists of ten drainage basins of the principal streams which flow generally to the northeast with their headwaters in the Barisan Mountains. The area lying northwest of the Djambi River has its origin in the Pretertiary and Tertiary rocks of the Barison Mountains, and the rivers have therefore deposited infertile sediments, from which only infertile soils could develop. The area, though not dry from the standpoint of rainfall in local areas, has developed a steppe type of vegetation because of the Föhn winds descending from the mountains during the west monsoon. Some relatively large areas of infertile peat soils have developed within the area, but no agriculture of importance has become established on the peat soils. The area is sparsely populated with forest products and rubber furnishing the primary source of income.

Southwest of the Djambi River the fertility increases as the sedimentary parent material has originated in volcanic efflata. Further south the volcanic activity has been more recent and the soils that have developed from this material have been more fertile. The influence of the Föhn winds also decreases towards the south as the height of the Barisan Mountains, that the westerly winds must cross, decreases. The area from the Djambi River to the south was probably originally covered by tropical high forest which has been destroyed by the _ladang_ culture of the people. In all of this area of Sumatra near the coast, there are the natural levees of coarse material along the river banks with gradations to the finer sediments towards the center of the interspaces between the streams. At flood stage the lowlands are covered with waters which cannot drain with the recession of the floods, and these areas are dried only by evaporation. It is in these areas, especially in the vicinity of the Moesi, Oegan, and the Komering Rivers south of Palembang, where _lebak_ culture, previously referred to, has developed.

The Lampongs is the name given to the southernmost portion of Sumatra adjacent to the Sunda Strait and the Krakatau volcano. In the eruption of 1883 previously referred to, most of the Lampongs was covered with Krakatau ash, and the subsequent erosion from the slopes and the decomposition in the valleys have developed some fertile and some infertile soils. In this area as a result of the _ladang_ culture the principal vegetation is _alang-alang_ grass. When one travels through this area by train from Palembank to Telok Betong, it is difficult not to have a feeling of depression from looking at the vast plains of this virtually worthless grass and the scraggly second growth forest that has been able to reestablish itself on the steeper, poorer slopes, so low in fertility that the farmers do not often burn them for dry rice or corn culture. Occasionally along the railroad or the highways it is possible to see well kept plantings of oil palm or rubber of agricultural estates. The areas which have been irrigated have sufficient productivity to maintain a fairly high level of agriculture, but as with the estates these areas are the exception and not the general rule. The Lampongs is an area of mixed success and failure of the pre-war efforts of the Netherlands Indies Government at colonization of the Outer Islands. The principal source of income of the small farmer prior to the war was from the production of pepper, but the gardens were destroyed during the Japanese occupation and have not yet been reestablished.

D. Particular Characteristics of Kalimantan

Somewhat detailed information for the tidal swamps of South Kalimantan is reported by C. L. van Wijk[1] as a result of the pre-war interest of the Netherlands East Indies Government in this area as a potential location for colonization for Javanese farmers. In his survey van Wijk found that it was necessary to combine usualy reconnaissance soil survey techniques with a vegetative survey because of the inaccessibility of many areas of the swamps. In addition to collecting samples of soil and ground water

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1. C. L. van Wijk, Soil Survey of the Tidal Swamps of Borneo in Connection with the Agricultural Possibilities, Contr. Gen. Agr. Res. Sta. No. 123, Bogor, Indonesia, 1951, 49 pp.

for laboratory analyses, van Wijk located the boundaries of various types of vegetation associated with different conditions of water and soil. These boundaries were subsequently checked for accuracy through the use of aerial photographs.

The tidal swamps of South Kalimantan cover an area of approximately 2.5 million acres between the Barito River at the east and the Mentajo River at the west and extend inland from ten to one hundred miles. The entire area is an alluvial coastal plain divided into a number of smaller plains by the north-south ridges between the major rivers of the area. Van Wijk quotes several geologists to the effect that this coastal plain is a relic of the Sunda peneplain which after the Pleistocene period was submerged and later filled by sedimentation from the Tertiary and Pretertiary formations of Central Kalimantan. The sedimentation kept pace with the rate of subsidence of the land, filling the tidal basin with silt upon which a halophytic vegetation became established. The vegetation accelerated the accumulation of silt and with the erratic currents resulted in the heterogeneous deposits of the area. A marine transgression occurred after the Pleistocene period and resulted in the interconnection of major streams through estuaries in their lower reaches.

During the rainy season the rivers overflow their banks almost continuously with the deposition of the coarser particles of sand along the banks and the deposition of the finer silts and clays between the rivers and adjacent to the coast. Near the coast this condition is accentuated by the high tide which also causes the rivers to overflow in the swamps. Perpendicular to the course of the rivers there is a gradation of silt particle size with the coarse particles near the stream banks and the finer particles midway between the rivers, which results in very faint slopes away from the streams towards the center of the swamps. The discharge of the rivers is so great that the brackish water line is only five miles inland in spite of the high tide. The tidal phenomenon, together with the topography, results in the lowlands between the rivers being continuously covered with water as the overflow into the basins at high tide is trapped by the natural levees at low tide so that the areas cannot drain.

About 1885 the Serapat Canal between the Barito and the Kapuas Rivers and the Kelampan Canal between the Kapuas and the Kehajan Rivers were excavated by hand to provide better channels of communication and trade. These canals were enlarged by the use of dredges from 1925 to 1930 and are navigable at high tide by motor boats, such as cabin cruisers, but at low tide by small canoes only. These canals have demonstrated that the lower areas of the swamps can be drained at low tide by gravity if drainage channels are cut through the natural levees. Because of the tidal influence in the lowlands, the floods during the rainy season are of little importance except for their influence upon the silt load of the streams, but the plains further inland to the north and east along the upper Barito and the Negara Rivers are covered during the rainy season from a few inches to several feet.

The original vegetation of these areas was trees and plants that could exist in the soft, acid, anaerobic condition of the soil but with their roots in the mineral sediments. Trees with aerial and stilt roots were common but are not prominent at this time. As the layers of plant detritus developed but, due to water-logged condition, did not decompose completely, the peat soils were formed and were influenced by the continuous deposition of mineral substances from the sub-soils. With the development of the peat soils the type of vegetation gradually changed to that which could exist entirely from the organic layers since their roots could no longer penetrate to the mineral sub-soil and had to subsist in an increasingly acidified organic medium with a decreasing supply of bases.

The swamp vegetation has to a considerable degree been pushed back into continuously wet areas by the repeated fires that occur during the dry season -- the uncontrolled burning by the farmers in the <u>ladang</u> type of culture. The swamp forest is replaced by grassy reeds and sedges or dense galam (Melaleuca leucadendron) forests. The galam trees have no commercial vlaue but are used as fire wood and to a small degree in pole type construction (Fig. 16). The initial stages of revegetation are sedges (Cyperaceae), reeds (Phragmites karka), and ferns which still cover large areas, but the predominant vegetation of the secondary forests is the fire resistant galam with the type of undergrowth governed by the frequency of recurrence of fires. The effect of the fires is most prominent along the natural levees which vary in width from a few hundred feet to as much as a mile because the levees are not continuously inundated. These levees are also the primary places of settlement of the population both along the rivers and along the canals on the artificial levees because the levees are the driest places to construct homes and also are on the roads of water, for in this area there are no highways and travel and transportation is either by dug-out canoe, by foot or on bicycle alongside the streams.

The principal characteristic of the alluvium common to all areas is the almost complete absence of soil particles larger than 0.05 mm. The sand fractions for the large part are old quartz and iron concretions with the percentage of sand decreasing and the percentage of iron concretions increasing from the western part of the swamps towards the east due to the difference of the inland mountains which are the source of the silt. The Barito River rises in the Meratus Mountains where there are many intrusions of basic rock including peridotite, gabbro, diabase, and andesite. The rivers farther to the west have their headwaters in the Schwaner Mountains, built up primarily from granites and other acid eruptive rocks but also including a considerable area of Tertiary hills of quartz sandstones. As a source of plant nutrients these minerals have little value.

The profile of the levee soils is characterized, according to van Wijk[1] by a grey-brown, somewhat humus, plastic silty clay or clay top soil to a depth of 10 to 30 cm overlying a grey or rusty brown veined, stickly clay subsoil poor in humus. Many of the levees have been cleared for cultivation of rice or other food crops but, when yields decrease due to the exhaustion of humus content, have been planted in ribber. The levee soils are not suited to the Bandjarese type of rice culture described later in the section on various types of rice culture.

The swamp soils have a layer of peat soil varying from 60 to 80 inches in depth under inundated conditions. The properties of the swamp soils depend almost entirely upon the percentage of organic content which varies from five percent to almost one hundred percent. Analyses of swamp samples show that the percentage[2] of readily oxidizable

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1. Ibid., p. 16.
2. Ibid., p. 20.

organic matter varies inversely with the total percentage present. In samples having only 0-5 percent organic content, 74 percent is readily oxidizable, while in samples having 60-100 percent total organic content, only 28 percent is readily oxidizable. The swampy subsoil is very sticky when wet, very hard when dry, and virtually impermeable except through channels remaining after the decomposition of roots, and while tending to limit movement of air and water through the soil, it is favorable for the Bandjarese method of cultivation referred to above.

The soil condition that will necessitate the most careful control of methods and of culture of irrigation and of drainage is the presence of a bluish grey, very acid clay found at an average depth of 40 inches in the eastern area. The clays, according to analyses reported by van Wijk[1] have a high content of water soluble sulphate (SO_3) with a strongly acid reaction (pH 1.7 to 3.2). This acid condition seems to indicate that the clay was the surface layer of the marine Barito Basin exposed to the brackish water influences of the Pleistocene Age as a true tidal marsh and that the surface layer was later sealed by a clay deposition and, after having been sealed, underwent chemical and anaerobic reactions that produced the present toxic condition. The toxicity of this soil is attributed not only to its high acidity but also to the

1. Ibid., p. 27.

presence of basic ferric sulphate and possibly to traces of toxic aluminum sulphate. Instances have been reported where this acid clay was plowed up into the topsoil and the rice crop for that year was a failure. Other instances have been reported where levees were constructed of the acid clay, and as rain water ran from it into adjacent areas, the vegetation was seriously retarded in its growth, if not killed completely. Along such levees observations indicate that after the levees have been exposed to the weathering forces for a few years the toxic elements are no longer a serious detriment to most plants.

Plans for extending the area of land under cultivation contemplate the excavation of drainage canals, construction of levees to control tide and irrigation waters, and the use of irrigation for rice culture. Because the toxic condition of the soil is known, adequate precautions can be taken to insure that drainage water from a toxic area is not used for irrigation in another area and to insure that ample irrigation water will be applied in all areas to prevent the toxic salts from being brought to the topsoil by capillary movement of the subsoil water. Since the land will be planted to such crops as corn or peanuts between crops of rice, it is likely that some toxic salts will be brought towards the surface by capillary movement of soil water. To prevent the upward movement of salts from becoming serious, the ground water level must be accurately regulated by controlled drainage and by the application of water in excess of irrigation requirements to flush any salts that may have been elevated through capillary action while the fields are in non-irrigated crops. Plans to utilize fresh water from the rivers for irrigation offer both the advantage of higher oxygen content and the absence of any traces of the toxic ferric or aluminum sulphates present in the surface water of the swamps.

At the edges of the tidal swamps of South Kalimantan rise the foothills of the interior mountains. Kennedy[1] has compared the island of Kalimantan to a low-crowned hat with its low mountains in the interior surrounded by gently sloping foothills and coastal plains. Because the interior mountains have not seen any volcanic action since the Tertiary Age, the minerals which contribute to fertile soils have been completely weathered and the soils are infertile due to the excessive leaching from the high rainfall and continuously moist soil conditions. Beyond the edges of the swamps the sparse population has carried on ladang culture until large areas are now covered with alang-alang grass as a result of the recurrent burning. Under the conditions of moisture in Kalimantan any areas of alang-alang can be definitely attributed to the effect of ladang, whereas some of the areas in the Lesser Sunda Islands may be attributed to the climate. The original

1. Kennedy, op. cit., p. 16.

vegetation of all of the interior of Kalimantan was tropical rain forest with many valuable species of trees as well as rattan and other secondary forestry products which have been scarcely touched for exploitation.

The interior areas do not offer the agricultural possibilities of other areas of Indonesia, but as the forests are cleared, an extensive type of agriculture with grasslands and livestock playing a major part may be practical.

The uniformity of Kalimantan's climate, even to the extent of not having any mountains high enough to materially affect the temperatures of large areas, implies that any differences in the soils must originate from the parent materials and the rate of their weathering. The weathering processes vary only with relation of the parent materials to the water, i.e., aerial weathering under a continuous leaching process or sub-aqueous weathering under continuous leaching in the absence of air.[1] The principal soil forming rocks of Kalimantan and their products are the sandstones of the Tertiary and other geologic ages which result in a silicious, sandy, red-yellow podzolic soils; the clay shales which gradually become a heavy, sticky clay; the marine marls which form a flocculated clay subject to considerable shrinkage or swelling with changes in moisture content of medium fertility but which are difficult to

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1. Mohr, op. cit., p. 387.

cultivate; the granites and quartz poryphyries in the western part which weather into yellow, brown, or red lixivium with iron oxide; and the granites of the Kapuas watershed, which is deeply weathered and has formed a yellowish-brown lateritic soil.

According to the summary of Mohr[1] the soils of Kalimantan are best adapted to extensive types of agriculture, including forest products, because of the natural poverty of the soil of most of the areas. In a comparison with the Netherlands Mohr observed that agriculture in the Netherlands did not develop until after its industry, commerce, and shipping had developed to a sufficient degree to support the establishment of an expensive type of agriculture in a naturally infertile area and that perhaps this should be expected for Kalimantan also and that its development probably would not be seen by his generation. The natural resources that are present for exploitation are those of the forest, the soils having ceramic qualities, and the minerals which include iron and petroleum. In addition some diamonds are found in South Kalimantan and as previously mentioned there is some gold in the western part. Because of the island's remote location and the problems of transportation, its development can never proceed at an accelerated rate even with the application of modern techniques.

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1. Ibid., p. 402.

E. Particular Characteristics of Sulawesi

As was true in attempting to briefly describe the soils of Sumatra, brevity can be obtained only at the expense of detail, for the Island extends from 2^{o} north latitude to approximately 6^{o} south latitude. While its equatorial position tends to minimize the influence of the monsoons, this fact is offset to considerable degree in many areas because of the high mountains which accentuate or nullify the winds' ability to cause rainfall. The characteristics of the soil are also varied, in that the parent material varies from recent volcanic efflata to Pretertiary and Tertiary granites and limestones, as well as the marine deposits evident in many of the coastal areas.

In Minehasa, the northern part of Sulawesi, most of the parent material of the soil is of volcanic origin. The soils, according to Mohr[1], are embryonal ash to red or brownish red lixivium which has not yet weathered sufficiently to develop the characteristics of the lateritic soils which may be expected eventually. The rainfall is such that drouth is unknown (Station 22; Table III), and the absence of slopes or plains has probably contributed to the prominence of coconuts as the principal crop. Some rice is planted and small areas have been irrigated, but the export of copra and import of food is the typical agricultural

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1. Ibid., p. 316.

pattern. The population is, for Sulawesi, fairly dense, but the copra export has always supported the prosperity of the people.

To the west and south of Minehasa lies the northern neck of Sulawesi with its mountains composed of rocks of all ages. The high mountains cause major variations in rainfall (Station 23; Table III), but in all areas the soils are subject to continuous but perhaps intermittent leaching. In addition to the red or brownish soils found in Minehasa, there are also some of the black earths of calcareous origin. Deforestation is a common result of the <u>ladang</u>, and although there is some irrigated rice, the rugged terrain has made corn and cassava the more important cultivated crops while copra, kapok, and forest products are of considerable importance. Local officials state that erosion is such a problem that the few harbors of the area have been seriously affected by silting.

According to Mohr, in Central Sulawesi the parent materials are metamorphosed shales, graywackes, limestones, and sandstones with some serpentine and periodite. The topography of high mountains and small valleys results in wide variations in rainfall, and here is found the driest place in Indonesia, according to available records. At Paloe the annual rainfall averages only 21.5 inches, and the xerophytic vegetation is comparable to that of the arid areas of the United States. In general, Central Sulawesi is still heavily forested and its agriculture is of little importance.

On the peninsula extending to the northeast from Central Sulawesi not only basic, igneous rocks and volcanic tuffs, but also tuffaceous marls, are present. The agriculture of the semi-nomadic tribes is almost entirely ladang so that a large portion of their livelihood is from the forest and from their goat herds. As has been noted about the other areas which are very mountainous, the rainfall here also varies widely in short distances.

In the southeastern peninsula of Sulawesi there are rocks of many types and ages including crystalline schists, paleogenic limestone, marl shales, and claystones, Neocene sandstones, marls, clay shales and coral limestone. The climate is characterized by a short wet monsoon of relatively high intensity (Stations 24,25; Table III) and by long seasons of drouth, the duration of which increases from north to south. Some of the mountain peaks have elevations of 6500 to 9700 feet, and at these altitudes a temperate climate exists. In this sparsely populated area there has been little development of the agriculture, although unpublished reports[1] show areas totalling almost 250,000 acres in the vicinity of Kendari where the soils and climate together with possibilities of irrigation

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1. S. Bone, Transmigration Plan for Demobilized Personnel, Djawatan Pertanian Rakjat, Propinsi Sulawesi, Oct. 23, 1950. Unpublished Report, 4 pp.

should make land settlement projects successful.

The southwest peninsula of Sulawesi is often referred to as the Toradjo lands in the northern part and the Macassar area in the south, the latter including the historic area of the Sultan of Goa. The soil forming rocks are a mixture of the Pretertiary schists and granites as well as limestone with some miners slate containing traces of copper and in many areas are influenced by the andesitic effusives of the volcanoes. This portion of Sulawesi is so strongly affected by the dry east monsoon that the products of thermal weathering along the south coast have been transported by wind to the plain of Goa near Macassar. Djeneponto is one of the driest locations in Indonesia according to records (Station 26; Table III). In the mountainous areas coffee Arabica has been especially successful between the elevations of 2600 and 5200 feet.

The principal areas of population concentration and agricultural development have been on the fertile sedimentary soils of the alluvial plains along the coast and in the limited areas of the mountain valleys. Rice is the principal crop of the rainy season, but in areas where irrigation is not yet possible, corn is planted and the latter is also planted over large areas in the dry monsoon. Many years ago the Buginese people of Southwest Sulawesi were famous as sailors, traders, and pirates, and even today much inter-island trade throughout the Archipelago is carried

in the sailing praos of these people. The picturesque landscape of the piedmont adjacent to the south coast, covered with xerophytic shrubs and sparse grass with the bare tuffs and limestones of the mountain blocks a few miles inland, is broken by trees only along the streams (Fig. 17).

The areas of the Sadang and the Bila irrigation projects, which were planned and initiated before the war, are located in the central portion of the southwest peninsula south of the lake region. The location of these projects is within itself indicative of the general fertility of the area as no such projects were undertaken by the Netherlands Indies Government if there was insufficient evidence of success. Other indications of the productivity of the area are the annual export of corn and rice to other areas of Indonesia and Mohr's table based upon 1930 census figures showing population densities varying from 151 people per square mile in the area of Pare-Pare to a high of 288 per square mile in the vicinity of Macassar excluding the city itself. Rising in the mountains there are numerous streams which flow throughout the year so that for the future development of the area there are many opportunities of extending the areas of the low lying plains.

F. Particular Characteristics of the Lesser Sunda Islands

The Lesser Sunda Islands include Bali, Lombok, Sumbawa,

Figure 17. South Sulawesi landscape showing coastal plains with mountains in background

Figure 18. Ravine showing geological and accelerated erosion in volcanic material of Central Bali

Flores, Sumba, and Timor as the largest and most important islands of the group, but in addition there are many smaller islands between and adjacent to these principal ones. Because of favorable factors of soils, climate, and population Bali and Lombok are by far the most important for the agricultural economy of Indonesia with a surplus of grain and livestock for export to food deficient areas and also some coffee and other export crops. Sumbawa has little export other than a small amount of livestock, and Flores has some copra and a small amount of coffee. Sumba is well known for the high quality of its sandalwood ponies and also exports cattle and carabao. Timor is unable to claim credit for any agricultural production above its own needs and generally must import some food annually.

Bali, except for the limestone areas of the northwest and the southern peninsula, is of volcanic origin with the parent material of its soils predominately andesites and basalts influenced to some degree by pumice stone. The northern coast has three plains, while the south coast is almost a continuous plain from east to west. The interior of the island is very mountainous with few valleys or plateaus of appreciable size. The coastal areas suffer moderate droughts each year with the most severe drought occurring in the north. In the interior there is no distinct dry season which is reflected in the large number of streams flowing out of the mountains especially to the south

coast. The streams have cut deep ravines (Fig. 18) through the easily eroded material and have exposed the soft tuffs which are quarried and used by the Balinese in the ornamental sculpture work that adorns their many Hindu temples. The soils generally are a grayish brown, but in areas not recently covered by volcanic material they are weathered more and have acquired a reddish brown hue. The central area is covered by forest except where replaced by agriculture, but to the east where the dry monsoon is more pronounced, a park landscape of grass with a few scattered trees is present.

In the vicinity of Karang Asem in the southeast the present landscape is sparse grass with very few trees on the slopes with the valleys in cultivation (Fig. 19). These uplands have little value in that there is too little grass even for good range lands and forest cover cannot reestablish itself naturally. The soils have developed under a continuous process of leaching except perhaps in this southeastern area.

The topography of Lombok is such that it may be compared roughly with a stock saddle -- the pommel to the north and cantle to the south. The horn of the saddle is truly represented by Mount Rindjani with its elevation of 12,000 feet, which according to Mohr[1] is at such a height that even in the absence of any further volcanic activity

1. Mohr, op. cit., p. 215.

Figure 19. Irrigated valley in Southeast Bali with savanna on slopes

Figure 20. Termite hill on poorly drained area of Sumbawa

no forest or even shrub growth can ever develop. The southern mountains or the cantle of the saddle appear from the air to be completely forested, completely without roads, and completely uninhabited. The mountains drop into the Indian Ocean on the south in a continuous series of bluffs which are not even the site of the fishing villages so common throughout the Archipelago.

The seat of the saddle in Central Lombok extends from coast to coast, and its irrigated fields really present a beautifyl panorama from the air. Mohr[1] describes the western half of this plain which rises to a height of 165 feet as being coarse ash from the volcanoes to the north-east. The ash has only partially weathered and is still very porous and of medium fertility. Since this portion of the plain is irrigated with mountain waters, rice production is at a rather high level. The soils of the eastern half of the area are described as being a heavy black clay, extremely plastic when wet and subject to the formation of hard clods and deep cracks when dry. This black soil has developed under intermittent leaching because of the severe eastern monsoon; with ample irrigation it is of medium productivity; without irrigation it is virtually worthless. These soils, which are referred to locally as _tanah malit_, are comparable to the adobe soils of the western United States.

1. Ibid., p. 217.

On the islands west of Lombok the influence of the dry east monsoon becomes more and more pronounced; the soils are weathered to a lesser degree, and the xerophytic vegetation becomes more and more pronounced. The result of the combination of these factors is a more primitive type of agriculture, and since the economy of Indonesia is based upon its agriculture, the islands lying to the southeast are the most primitive and least developed in all respects.

Sumbawa is the first island to the east where the influence of the dry monsoon is severe for five to six months (Stations 65-68; Table III). From the standpoint of climatological study these four stations are inadequate, but at the same time they are located in the only areas where agriculture has attained any semblance of permanence. From the appearance of the vegetation viewed from the air, there is more ample rainfall in the mountainous areas along the south coast of the island and forest cover has long been established, but in contrast to the Greater Sunda Islands, where evergreen trees are the general rule, many deciduous trees are visible.

In 1815 Mount Tambora erupted[1] and covered all of the island to a depth of at least one and one-half feet with gravel which is now mixed with other volcanic materials. The sloping lands of Sumbawa are practically all covered with gravel, stone, or boulders. Underlying the partially

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1. Ibid., p. 220.

developed lateritic soils are limestones, calcareous tuffs, and some marl. In the small valleys along the north coast the heavy black soils predominate, and where irrigation water is available, there is the appearance of relatively high prosperity among the people. Along the road which follows the north coast very closely, there are large areas of calcareous limestones of marine formation on which there is little semblance of any type of soil. Because of the long dry season and the small watersheds of the rivers there are very few streams which flow throughout the year, but the stone strewn stream beds are mute evidence of the intensity of the wet monsoon floods. In most of the valleys mentioned above the presence of large termite mounds are indicative of heavy clay, poorly drained subsoils (Fig. 20).

The principal crops are rice and corn in the valleys and pigeon peas on the slopes with production of the latter sufficient for a small amount to be exported. The pigeon peas are the product of ladang culture. The grass and shrub vegetation of the slopes is burned prior to the end of the dry season and the peas are broadcast without any further preparation. The corn and rice are given much better attention, although in the eastern part of the island some of the rice land preparation is accomplished by driving caraboas around in the fields after they have been flooded; however, according to local officials, wooden

plows with steel points and wooden harrows are gradually replacing the use of livestock alone. There are a few coconut trees along the stream beds and scattered through the valleys, but these are for local consumption. Only one estate has been developed on the island, and it is said to consist of approximately 1250 acres of coffee arabica in the central mountains. Livestock, in excess of the demand of the island, graze many of the mountain slopes and are exported in small quantities to Sulawesi and Java; however, this export will not materially increase until consumer commodities are available in sufficient quantities to offset the pride of ownership of the cattle.

The percentage of areas with fertile soils capable of being irrigated seems to decrease in the Lesser Sundas in proportion to the distance one travels from Java. The landscape of Bali has long been world famous for its terraced slopes and its productivity. Lombok, while not having worldwide fame, is well known in Indonesia for its productive plain in the center of the island. Sumbawa has small areas of irrigated fields in the west, in the central portion, and slightly more in the eastern residency of Bima. Flores shows a continuation of this decrease, especially in the eastern half through which the author has travelled.

The area of irrigated land on Flores is negligible because the combination of its steep topography and the almost complete absence of year round streams has made the establishment of irrigation a more difficult task than the primitive people have been able to cope with. Because of the recent activity of its numerous volcanoes with their andesitic and basaltic effusives and ash, the fertility of the few plains and gentle slopes offer a greater potential than do the soils of Sumbawa. Fourteen of the volcanoes are still classed as active with the most recent eruption that of the Laki-Laki volcano near Hokeng in East Flores. This eruption was mostly ash and lasted about an hour. Flores is similar to Sumbawa in that much of its terrain is very mountainous, and it is doubtful whether more than five percent of its land area can ever be satisfactorily developed or utilized for cultivated crops. This low estimate is based upon the observations of a soils specialist of the Soils Research Institute and the author after travelling from Badjawa in Central Flores to Larantuka near the eastern end of the island. If there were adequate water, no doubt the slopes of many of the mountains would acquire the terraced appearance of Bali and Java, but in the absence of adequate water the labor requirement for such work cannot be justified. Mohr[1] made the observation that Flores is so steep that if the sea should rise as much as 325 feet its total area would not be materially changed. Along the coast the depth of the sea increases

1. Ibid., p. 230.

rapidly, so much that in spite of the sediment transported by the streams during the rainy season no large alluvial plains have developed over large areas.

The climate of Flores differs from most of the other islands in that much of it lies at elevations greater than 3250 feet and is therefore cool, but the lowlands along the north coast east and west from Maumere are arid and hot. The dry winds of the east monsoon pass over the highlands and lose the greatest portion of their moisture before reaching the north coast so that the severe dry season continues until the end of November (Station 72; Table III). In the vicinity of Maumere during the dry season strong winds rise in the morning and continue until dusk. Wind erosion is of considerable importance because virtually all of the forest cover of the slopes has been destroyed by the ladang farming of the people. The lowland vegetation is xerophytic shrubs and sparse grass which in October seems to have lost all semblance of life. There are coconuts in the watercourses which are usually dry on the surface, but water is obtained from the shallow wells which are often dug in the channels. In the absence of vegetative cover on the mountains, accelerated erosion has become a serious problem, and according to the Radjah of Maumere the hydrologic cycle has changed in his lifetime in that, because of the excessive runoff, infiltration has decreased during the wet monsoon and many small streams and wells, where there was formerly water throughout the year, are now dry early in the dry monsoon.

As one leaves the lowlands he cannot fail to have something of a feeling of depression upon viewing the stony, boulder covered slopes with their shallow soils which offer little opportunity for agricultural development. Because of the nature of the parent material, the streams have developed steep ravines through the geologic ages, and the fertile valleys found on many of the other islands are non-existent. Even more worthless in appearance than the stony volcanic slopes are the crustaceous limestone deposits along the south coast east and west of Ende and along the road crossing from the north to the south coast as one travels from Maumere to Larantuka. These areas consist primarily of crustaceous limestone with some fossils, and little soil worthy of the name has developed. From the combination of soils, climate, the ladang culture of the people, and the tradition of burning some of the grasslands while hunting deer and other game, the naturally weak forests of Flores have been almost completely destroyed.

There are a few areas on Flores which are in sharp contrast to the adverse observations above. Lying east of Badjawa in Central Flores are the rolling plateaus of Lolo and Molanusa. The surface soils of these areas are young, fertile, humic brown soils that are a deep brown, almost black, color, on which good yields of unirrigated rice and corn are obtained. Because of their elevation these areas have a less severe dry season, and the grass on the slopes furnishes more or less adequate range for livestock. The major problem of the area, however, is the lack of year-round water supply both for the people and livestock. At Pudjanala and Molanuza inspection of the soil showed that the almost black fine sandy loam extended to a depth of thirty to forty inches above a reddish-brown subsoil with considerable clay and some concretions. It is on these soils that the Catholic Mission of the Order of the Divine Word previously referred to has established its most successful agricultural enterprises.

On the north coast of Flores lies one of its few alluvial plains. The river empties into a bay protected by coral reefs and what were formerly two small islands which are now connected to the mainland[1]. The total area of the Mbai plain built up by the alluvial deposits of the Air Sissa is approximately 22,500 acres, of which 10,500 acres is saline and will require very accurately controlled irrigation and drainage before it can be farmed satisfactorily. The Sissa rises in areas of volcanic origin and the soils of the plain are of adequate fertility to maintain production at high levels with irrigation during the wet monsoon, but because there is a high concentration of sulfates

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1. M. van der Voort, F. W. J. van Es, and H. A. Haantjens, Soil Survey of the Mbai Plain, Contr. Gen. Agr. Res. Sta. No. 124, Bogor, Indonesia, 1951, 29 pp.

in the river water during the dry monsoon, it will not be satisfactory for irrigation water at this time. At the present time the plain is sparsely populated with most of the people living near the foothills. There is little farming except on the terrace soils that have a high moisture retentivity because of clay content. The saline soils are poorly covered with halophytic shrubs, and the non-saline soils have xerophytic shrubs including cactus which cannot be burned for ladang and are used for grazing lands but are of little value because of the long dry season. There was no rain in this area during the first ten months of 1952. Scattered throughout the area are many lontar palms from which the people collect the nectar of the blooms as a beverage (Fig. 21). This nectar may be consumed fresh, but more often it is allowed to ferment and is consumed as a beer or is distilled in primitive stills to make an alcoholic beverage known as tuak[1]. Plans for the construction of a diversion dam in the Air Sissa have been prepared and location stakes set for the structure.

In the rolling hill lands between Mbai and Badjawa there are many small fields fenced either with rock and sod or with lamtoro (*Leucaena glauca*) and dadap (*Erythrina* sp.) which form a thick living fence against roving animals, domesticated and wild. As previously mentioned, the

1. Tuak is a beverage from the nectar of the bloom of the *Palmyra* palm. The nectar is collected in bamboo tubes or baskets from the palm leaves and fermented into beer or distilled to make a rather strong alcoholic liquor.

Figure 21. Bamboo tubes used for collecting nectar from Palmyra palms

Figure 22. Mouth of underground river near Waikebubak, Sumba

principal hindrance to an increase in livestock is the shortage of water. The topography is well adapted to the construction of a large number of stock watering ponds but no information is available as to the permeability of the soils, and any undertaking should initially be on a limited experimental scale. Although there is some dry rice planted in this area, the principal field crops are corn and cassava; bananas are the most important of the fruits. It is in this area that one may see bamboo forests covering several hundred acres in a block with the bamboo four to eight inches in diameter and with individual clumps measuring ten to fifteen feet in diameter. The bamboo attains heights of twenty to thirty feet, and the shade is so dense that all other vegetation is eliminated. Although used in large quantities by the people, it seems to have no commercial value.

In the western third of the island, from Maumere to Larantuka, there are five or six areas which the combination of soils, topography, and available water offer good possibilities for agriculture. In two of these areas, at Hokeng and Nangahale, the Catholic Mission has enterprises. Hokeng lies in the center of the island at an elevation of about 2000 feet, and here the Mission of the Order of the Divine Word has more than 250 acres in coffee robusta which has done very well, but the experimental planting of kapok as a shade crop has proved to be

unsatisfactory. The shade has not been adequate for the coffee, and the competition between the kapok, coffee, and cover crops has made the kapok yields too low to be profitable. At the present time the kapok is being replaced by Albizzia stipulata. At Nangahale since the war the Mission has acquired the concession of a former estate and in this coastal area over five hundred acres is in coconut palms for copra which will be expanded to about 1250 acres. The remaining areas are now subject to inefficient ladang culture of the people with corn, cassava, and rice being of the most importance, but there is a small amount of cotton produced and used locally.

Related to and perhaps a contributing factor to the primitiveness of the island is the high incidence of malaria among the people. In the three areas of Konga, Maumere, and Geliting the incidence, according to a survey reported by the resident public health physician in 1947, was 88 percent. In the vicinity of Konga there is a level plain of 1000 to 1250 acres partially irrigated by primitive irrigation methods, but the fertile sandy loam overlying a heavy subsoil is only cultivated in part by the people. It was also reported that in this area some elephantisis occurs. The debilitating effects of these diseases, as well as yaws, are certain to have retarded the development of the area.

To the south of Flores across the Sumba Strait lies the smaller island of Sumba which differs from the northern islands of the Lesser Sundas in many respects. While Flores, Sumbawa, Lombok, and Bali derive their principal soil characteristics from recent volcanic materials, the volcanic activity in the history of Sumba is of a much earlier age. The statement of Mohr[1] that Sumba is covered with marls and limestones north of its long axis, while in the south igneous rocks are thrust upwards through the sedimentary rocks in the southern half as mountains is substantiated by observations. The highest eruptive mountains are surrounded by marly marine tuffs, tuff marls, and calcareous marls except at the south. Although eruptive materials are present over most of the island, they have contribued little to the formation of fertile soils as they are principally from the Neocene Age and the weatherable minerals have already leached out. The primary source of soil forming material for Sumba has been the marls which, however, are not true marls, for they originated from marine deposits of calcium carbonate of organic origin mixed with volcanic material.

Because of the prevalence of limestone formations a large portion of Sumba has a Karst type of landscape. Among the several impressive features of the landscape along the road from Maingapoe to Waikebubak and on to the west coast are the many valleys, both large and small, from

1. Mohr, op. cit., p. 246.

which there is no surface drainage. Many of these small valleys have a natural drainage well at the lowest point where cave-ins have occurred following the solution of the calcareous formations below the surface. In some valleys streams rise, flow for a distance, and then disappear beneath the surface, while in other areas underground rivers emerge from the mountain side. Figure 22 shows the emergence of an underground river near Waikeboebak which had a discharge estimated to be approximately 500 cubic feet per second at the end of the dry season of 1952.

The limestone formations of Sumba which Mohr[1] preferred to call tuffaceous limestones are stratified to a marked degree and though generally horizontal are warped in many placed. The horizontal strata (Fig. 23) exposed on the hillsides give the appearance of terraced fields from the air before one has seen them on the ground. The outstanding example of stratified layers is perhaps fifteen miles east of Waingapu where between the low plateau and the coastal plain there is a distinct shelf some fifty to two hundred feet in width and at least five miles in length.

According to available rainfall records there is no place on Sumba with less than thirty inches annual rainfall, but at Melolo three-fourths of this falls in the six-month rainy season, and it is worthy of note that the average monthly rainfall is just over one inch in the months

1. Ibid., p. 249.

Figure 23. Landscape on Sumba showing stratification of rock

Figure 24. Lewapaku plain, Sumba

of May and November and one-half inch or less from June through October (Station 76; Table III). While the dry season is more severe at Waingapu than at other places of record, the same pattern holds true. Under a climatic condition such as this the normal development of black earth from the parent material of marl would be expected and is true except as modified by erosion. On most of the slopes of Sumba the partially developed soils are a grayish black, while in the valleys where alluvium has been deposited by water or wind the soils are black. The plains of Lewapaku and Anak Alang on the road between Waingapu and Waikebubak are almost as black as soot.

The Lewapaku plain (Fig. 24) at an elevation of about 2000 feet covers an area of approximately 15,000 acres with topsoil twelve to twenty inches deep, which varies from clay loam to clay, over calcareous marl. Internal drainage of the area is not good; there are several areas where surface drainage simply fills small lakes which usually evaporate in the dry season. The plain of Anak Alang (Fig. 25) has an area of approximately 20,000 acres, and in general its soils are more fertile than those of Lewapaku. The soils have developed from mixed marly and tuff materials deposited upon the underlying marly limestones of the plain and have weathered under marshy conditions.

From limited observations Dames[1] states that the principle

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1. T. W. G. Dames, Personal Communication, May 20, 1953.

Figure 25. Land preparation with steel bottom plow on Anak Kalang Plain, Sumba

Figure 26. Gilgai relief in coastal area of North Sumba

soil type appears to consist of fifteen to twenty inches of black, humic, crumbly, silty loam topsoil underlain by a reddish-brown, compact, moderately permeable lateritic, clay subsoil at about thirty inches grading into a brownish-yellow clay containing a few iron-manganese concretions and in turn grading into a yellowish-white plastic sticky clay with strong yellowish-red mottling. In the sunken areas the same topsoil is underlain by a yellowish-brown clay, with many bluish-black iron-manganese concretions, which hardens upon exposure to the air into a steel-like hardpan. This true "laterite" layer usually is about six inches in thickness but in places may be much thicker and often occurs at very shallow depths. This concretionary layer is underlain by a yellowish-white, strongly yellowish-red mottled, very compact and stiff, plastic and sticky, impervious clay. It appears that this soil properly should be classified as a ground-water laterite under the classifications of the Great Soils Groups as used in the United States.

About five miles west of Waikebubak is the smaller plain of Waikelowo with an area of approximately 2500 acres through which the underground river previously referred to flows after it emerges from the mountain. There is also another smaller stream with year-round flow in this plain. The soils of the Waikelowo plain are similar to thos of Anak Alang, but the agriculture has been further developed as a result of the presence of these two streams which

provide water for the primitive irrigation systems developed by the people to irrigate about 1500 acres for rice culture.

The above plains are the only areas of appreciable size that are really well adapted to cultivated crops along the one road from Waingapu to the western end of the island, a straight line distance of about one hundred miles but one hundred and fifty or more with the meanderings of the road through the mountains. There are other areas which are cultivated and where the fertility is reasonably high, but without exception these areas lie in the small valleys because the soils on the slopes are so shallow and infertile. Ladang culture is practiced by the people on the slopes, and here as in Flores one finds land prepared with sharpened sticks used as dibble bars. After the grass has been burned off, the land is turned over in large lumps and left until there is rain; after it rains, rice is planted between the lumps and corn on top of them. Small holes are made in the lumps or between them with a small stick where the seeds are planted and covered by hand.

Along the west coast of Sumba is the coastal plain of Kodi. The width of this plain varies from about a mile to as much as ten miles, and the soil is a gray black sandy loam of very low fertility. There are no streams -- only a few small springs at the foot of the hills from which the water disappears into the sand; there are a few wells from which the small population is able to obtain water.

East of Waingapu alternating red and black limestone soils have developed where the surface is not completely covered by crystalline limestone. On the flatter slopes there are soils to a depth of four to six inches and in low places to a depth of two feet or more, but as on the rest of Sumba lowlands only along the watercourses are there any trees. In the mountains of the interior areas there are forests, but it is very doubtful whether much of Sumba has ever had a closed forest cover. On both the limestone capped plains, the limestone soils are erodible to a high degree and vertical erosion appears to be a serious problem in that large areas have acquired a Gilgai micro-relief. In Figure 26 the Gilgai landscape is shown as it occurs a few miles west of Melolo on the north coast. One could almost imagine that some giant size basin lister had been used for the conservation of water and the prevention of erosion, but the landscape actually is the result of vertical erosion through the drainage wells which are in the bottom of each low place. The depressions are twenty to twenty-five feet in diameter; near the center of each there is a small hole four to six inches in diameter through which drainage and erosion take place. In the background near the coast are the Palmyra palms (Borassus flabellifer) that appear throughout the Lesser Sundas where there is insufficient moisture for coconuts.

Around the eastern end of Sumba lies the coastal plain

of Mangili which varies from two to five miles in width and is ten or twelve miles in length. The soil of this area is black clay loam to a depth of twelve to twenty inches underlain by a reddish-brown compacted subsoil. Although this is one of the few areas of Sumba where year round streams are present, the plain is not severely dissected. From a small technical irrigation system partially completed prior to the war, approximately five hundred acres are now being irrigated. It is possible that this area could be enlarged by fifty percent; however, the population is not able to cultivate more land. Between the Mangili plain and Melolo are more hills covered with the crystalline limestone where the soils are alternating red and black with no appreciable depth except in the few low places that occur. Near the home of the Radjah of Rendeh there is a small valley (Fig. 27), in which there are many coconut trees and small irrigated rice fields, but otherwise the landscape is a desolate waste of sparse xerophytic shrubs, trees, and grass wherever this vegetation is able to exist upon the thin soils between the crystalline limestone rocks. The only natural vegetation of value is the cayeput of the eucalyptus family (Melaleuca leucodendra), the resin of which yields an oil of medicinal value and the bark of which not only yields some tannin but because of its fibrous nature is used in the caulking of small praos by the native fishermen.

Figure 27. Irrigated valley near the home of the Radjah of Rendeh, Sumba

The few small gardens of the people are developed by removing enough stones from the surface to construct stone fences around the small fields and to enable the people to farm between the rocks that remain. The statement of the North Georgia farmer who said that he could prepare his field of Madison gravelly loam soil, plant, and cultivate the crop without seeing the soil beneath the gravel cover could certainly be used in describing the stony surface condition of these soils. The principal crops are corn, cassava, beans, and small amounts of dry rice because of insufficient moisture for the latter.

Before concluding the discussion of the Sumba soils and vegetation, it is in order to mention the livestock production which is related to the soils and climate. Just as in the limestone soils of Kentucky and Tennessee the grasses seem to be especially desirable for horses, so are the grasses of Sumba. At least both locations have long been famous for their fine horses, the Thoroughbreds from Kentucky and the Sandalwood ponies from Sumba. These Sumba horses, which actually are the pony size typical of Far Eastern horses, may almost be described as miniature Palominoes, wiry, strong, and highly prized throughout Indonesia. There are many herds of horses moving over the rocky hills in search of grass and water tended by their fierce looking herdsmen. There are also many herds of fine Angol (Brahma) type cattle and caraboa. The latter are

highly prized by the people who, after killing them for their ceremonial feasts, use the horns for door steps or ornaments on their houses. At the home of the Radjah of Rendeh a pair of caraboa horns from a bull which died at the age of twenty-three had a spread from tip to tip of 128 inches. The walls of his house were from caraboa hide stretched between the wooden framing.

Throughout the coastal area of Sumba the Palmyra palm is common and is the source of a large portion of the necessities of life of the natives. The leaves are used to make vessels for carrying water or tuak and also are split into narrow strips for weaving into hats, baskets, and other household items or decorations. The coarse fiber from between the sheath of the leaf and the trunk of the palm furnishes the material for thatch roofs and also for ropes. Although the nuts from the Palmyra palm are of much poorer quality than the coconut palm, they also provide a beverage and the meat is sometimes a source of vegetable oil for cooking.

The easternmost island of Indonesia of appreciable size (excluding Irian) is the island of Timor. For its size this island, according to Mohr[1], is derived from a greater diversity of rocks than most of the islands of the Archipelago. This is indeed a broad statement when it is

1. Mohr, op. cit., p. 260.

apparent from other islands of the Lesser Sunda group that any of them would make remarkable geological laboratories. Material of all ages is available for study to one who travels along the few roads and the changes from one age to another age are often so abrupt that, unless close attention is given to formations and morphology along the road, the change is complete before one is conscious of the transition. Timor has lowlands along its longitudinal axis with mountainous land to the south and higher mountainous land to the north of its axis.

There has been no volcanic activity since time prior to the Tertiary age, and the lack of volcanic ash together with its climate has rendered the soils of Timor far less fertile than those of the other islands of the country. Since the longitudinal axis of Timor lies perpendicular to the direction of the southeasterly winds of the dry monsoons, much of its area is marked by long dry seasons of six to eight months. Kupang in the southeast of the island lies behind high terrain so that during the east monsoon only dry winds descend on it. Less than 25 percent of the island's annual rainfall (55 to 60 inches) occurs in the six to seven months' period April - October (Stations 77,78; Table III). In the processes of soil formation there has been considerable influence from both the erosive forces of the water and of the wind. Another influence of climate of Timor has been the natural savanna landscape of many of the lower areas where trees could not compete with the grasses. Under the grasses many large areas of black or red earth soils have developed especially over the crystalline deposits of limestone originally deposited under the sea.

The travels of the author on Timor have been limited to the vicinity of Kupang and were near the end of the dry monsoon when the area appears as a desert. At this season of the year a few fields are being prepared for the planting of corn or rice with the beginning of the wet monsoon, but most of the area is covered with the crustaceous limestone and alternating red or black fine textured soil. The vegetation primarily is that of sparse xerophytic grasses and shrubs with a few of the Palmyra palms in the lowest places where the most subterranian moisture is available. The amount of limestone present is best told, perhaps, by saying that an area of one to two acres can be partially cleared of stone if the stone is utilized for the construction of fences three to four feet in height around the fields from which the stone was removed.

In the higher regions of more moisture and lower temperatures forest cover has existed, but it has never been the tropical rain forest. It is on Timor, as well as on some of the other islands of the Lesser Sundas, that sandalwood has long been sought. This valuable wood has almost disappeared and at the present time can be cut and exported only with special licenses from the government. Some of the areas with better climatic conditions have developed more fertile soils, but the possible agricultural development is greatly restricted by the relatively poor soils and the lack of good water supplies throughout the year. The primary crops of the area are corn, cassava, and rice. The greatest agricultural development has been in livestock production but this has, perhaps, been materially retarded by the absence of transport vessels which would permit the livestock to be sold elsewhere.

G. Particular Characteristics of the Moluccas

From the standpoint of size, Halmahera, Buru, and Ceram are the most important islands of the Moluccas, but traditionally the smaller islands of Ternate, Tidore, and Amboina have dominated the trade and government throughout history. Detailed information on the soils of the islands is not available, but the climate is definitely equatorial and continuously moist (Stations 29-34; Table III). The season of the most rainfall varies from one island to another and even from the northern half to the southern half of some of the islands and is controlled by the location of a particular area with reference to the mountains and the direction of the prevailing winds.

The soils[1] of Amboina, Buru, and Ceram are not influenced

1. Ibid., pp. 296-305.

by young volcanic material but have their origin from old igneous rocks and from uplifted marine sediments which include coral. The Banda Islands, lying between Ceram and Irian, on the other hand are almost completely of young volcanic origin except on the smaller islands and along the low coastal areas of the larger islands which are covered with coral. Almost all of the soil on Halmahera, to the north of the above named islands, has originated from old basic eruptives, although opposite the islands of Ternate and Tidore and across the base of the Northwest Peninsula there are old tuffs and at the northern extremity younger volcanic efflata is the parent material.

Because of the high rainfall through the year and the sparse population, the natural rain forests have not been destroyed by the ladang culture of the people; in fact, the continuously moist conditions of the forest seem to have prevented ladang by remaining too wet to permit clearing with fire. The high forest contains many trees more than a hundred feet in height, and it is under these that the cloves and nutmeg trees have flourished. The low areas are the native habitat of the sago palm, the principal source of starchy food of the Moluccas, which with fish and vegetables constitutes the principal diet. Even the vegetables are primarily from the wild plants, not the customary garden vegetables of other areas.

CHAPTER VIII

DEVELOPMENT OF INDONESIAN AGRICULTURE

Indonesian agriculture is difficult to describe in general terms, for every locality has its variations of *adat* or ancient customs pertaining to crops planted, to ownership or tenure rights, to methods of tilling the soil, and in the cultural level of the people themselves. Most literature about the agriculture of the Archipelago refers to the dual economay with the foreign owned estates established for the production of agricultural commodities for export and the native farmer practicing a subsistence type of agriculture. The native farmer and his family usually cultivate about two acres on Java, Madura, and Bali and a little more in the Outer Provinces, whereas the concessions of the estates on Java are measured in hundreds of acres and in the Outer Provinces in units of thousands or even ten thousands of acres. The largest areas of estate concessions are on Sumatra, with Java second and Kalimantan third. The area of concessions in other islands is very small.

The farmers' agriculture is characterized by a minimum investment in tools and almost always is a very primitive type of farming, while that of the estates is heavily capitalized and is conducted by well trained agricultural scientists and other technical personnel but with a mixture of primitive and modern techniques in the field. The farmer usually possesses neither adequate storage facilities nor even simple processing equipment, while the estates have whatever facilities are necessary to process their products for market or export.

Prior to the Twentieth Century the estates produced almost all of the agricultural commodities for export, but a marked change is recorded by Kennedy[1] showing the percentage of agricultural exports produced by farmers in 1898 to be 10 percent, in 1913 24 percent, in 1930 31 percent, and in 1937 46 percent. Data from reports published show that this trend has continued since the war; in 1950 68 percent of agricultural exports were the products of farmers[2].

Certain export commodities have typically been produced by farmers while others have been restricted to the estates. The limiting factors of adaptability of export commodities for farmer production appear to be the capital investment required for production and processing, the time required before a return is possible, and the amount of technical knowledge and supervision necessary for the production of product. The pre-war figures of Kennedy showed sugar, palm oil, and quinine to be entirely the products of the large estates, while the farmers produced all of the pepper, 98

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1. Kennedy, op. cit., p. 61.
2. John E. Metcalf, The Agricultural Economy of Indonesia, Agr. Monograph No. 15, U.S.D.A., Washington, 1952, 100 pp.

percent of the copra, 80 percent of the tapioca, 70 percent of the coffee, but only 23 percent of the rubber, 15 percent of the tea, and 8 percent of the tobacco. In 1950 the rubber estates produced 25.8 percent of the rubber exported and in 1951 26.7 percent based on weight[1], but the percentage of value of exported rubber was 27.6 percent in 1950 and 32.5 percent in 1951 as the average grade of the estate rubber is better than that of the farmers due to better processing facilities and techniques.

When the Portugese traders lost control of the East Indies to the Dutch at the beginning of the Seventeenth Century, the primary interest of the European countries was in the "Spice Islands" or the Moluccas. The Dutch influence was under the United East India Company which initially was interested only in trading monopolies in the Archipelago[2]. The Portugese had formerly maintained their headquarters in the Moluccas but were forced by the Dutch to shift their trading base to Macassar where they remained until 1667. Since that time Portugese influence has been negligible in the area except that they still possess the eastern half of the island of Timor. Because of its favorable location on shipping routes the East India Company established its headquarters in West Java, and under its Netherlands charter had a monopoly on all trade in Asia.

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1. Ministries of Economic Affairs and Agriculture, Warta Ekonomi, op. cit., p. 193.
2. Vlekke, op. cit., pp. 105-145.

In 1610 Jan Pieterzoon Coon was appointed Governor-General of the Company, and in 1619 his troops burned Jacatra and upon its reconstruction renamed it Batavia. Shortly after the burning of Jacatra the Chinese introduced sugar cane, and sugar production soon reached a millions pounds per year.

About 1630 the gradual change of the Company's interest from trade to agriculture began and could have been influenced by the inability of the population of the Moluccas to repay crop-advances, after which the Company confiscated the property and reduced the people to slavery; however, it seems reasonable to assume that the Company merchants realized the potential productivity of the fertile soils and the warm climate. In order to maintain their position in the Moluccas, the Company paid the Sultan an annual allowance for his support of their claims. The general policy adopted by the Company was to recognize any local ruler who could maintain control of his people and to support him in return for concessions including a monopoly of trade. By about 1680 all major Indonesian states had disintegrated because of Dutch naval superiority, and Company control became the principal authority, although there were many local rulers who neither recognized this authority nor granted the desired trading concessions. Distributed almost throughout Nusantara are references by Vlekke to the Company's support of various local rulers against the rulers of their neighboring states. The support of the

Company either in the form of munitions, troops, or perhaps both was given in return for trading monopolies, and very often the local ruler found that through such concessions he had lost control of his own territory when the inter-tribal conflict was over. The policy of granting allowances to the radjahs and sultans to insure their acquiescence to the Company became more and more the standard practice, but in spite of this policy Dutch influence did not penetrate Achin in North Sumatra or the island of Bali until the beginning of the Twentieth Century.

By the process of not renewing the Company charter the Netherlands Indies Government came into existence in 1799, and the above method of controlling the country through native rulers had become the accepted procedure and was continued.. At the time of the surrender of the Company charter the Netherlands government paid the stockholders one hundred and thirty-four million guilders for their property holdings. Incident to the indirect rule through native rulers, the Company and later the government found the Eastern concept of the ruler owning everything within his domain convenient to their goal of increasing trade, in that they were enabled to sell lands or to grant concessions to corporations with sufficient capital to establish plantations from which there could be no immediate return or to establish factories for the processing of crops that could be produced both on the lands of concession or on the lands of the farmers of the vicinity. The concept of everything being the property of the ruling authority also enabled the collection of land-rents in lieu of property taxes, sometimes in money but more generally in portions of the crops varying from 25 to 50 percent. This concept also enabled the government to assign quotas of commodities for export which the local rulers must deliver in return for the support of the government.

Today land tenure and property ownership in Indonesia perhaps have more facets than any other problem confronting the government and the farmers. Many of the tenure problems are the result of the combination of adat, the policies of the Netherlands East Indies Government, and to a minor degree the policies of Sir Thomas Raffles, who was the British Governor General from 1811 to 1816 after an expedition of the British East India Company under Lord Minto defeated the Dutch and established administrative units in Malacca (Malaya), Bengkulen (S.W. Sumatra), Java, and the Moluccas. In 1813 Raffles issued a decree which formalized the concept of complete ownership of all lands by the government. Excerpts from the decree stated that, "The Government lands will be let generally to the Heads of Villages, . . . They will re-let these lands to the cultivators, under certain restrictions, at such a rate as shall not be appressive, and all tenants under Government will be protected in their just rights, so long as they shall

continue to perform their correspondent engagements faithfully."[1]

Soon after the Dutch came to Indonesia, coffee was introduced and its culture was encouraged over the Archipelago. Within about twelve years after its introduction production reached twelve million pounds annually and was so profitable that the people were increasing areas under culture beyond the requirements of the Company for export to Europe. Areas for coffee production were restricted, and because even under fixed prices it appeared to the Company officials that the people were becoming too rich, various practices were resorted to in order to increase the Company's profit in the export trade or to enrich the officials themselves. One such practice was to require the delivery of "mountain piculs" of 225 pounds while paying for "Batavian piculs" of 125 pounds[2]. The difference in weight was equivalent to the loss of weight in transit, so the officials claimed. This was during the period that as a result of illicit trading officials of the company were able to return to Holland after a twelve to fifteen year period with several hundred thousand guilders. Thus it is unlikely that the Company received all the profits of such sharp trading practices.

Under the restricted plantings allowed and the

1. Ibid., p. 182.
2. Ibid., p. 182.

unfavorable marketing system the people lost interest in coffee production. In order to maintain the export trade, the Company ordered the regents or local rulers to deliver fixed amounts of coffee and assigned supervisors to the various territories to insure compliance with the order. The supervisors became known as "coffee sergeants" and were the real beginning of the civil service of the Netherlands Indies Government. Coffee soon became a Company enterprise and later was continued as a government enterprise which was not completely abolished until 1917.

With the return of the Dutch to Indonesia in 1817, under conditions of a treaty with the British, a department of agriculture, arts and education was established. The first head of this department was Professor Gaspar Reinwardt, a Prussian botanist who had emigrated to Holland and thence to the East Indies. Professor Reinwardt was responsible for the establishment of the Botanical Gardens of Buitenzorg (Bogor) for the collection of tropical flora from throughout the Archipelago and other tropical areas of the world. The gardens became world renowned and for many years have maintained facilities for visiting scientists from all over the world to come for study and work in addition to exchanging scientific information through the media of publications. The primary objective of the gardens was to collect plant material and through the processes of selection or breeding to make available those which could be produced profitably for export.

Among the importations through the Botanical Gardens have been the oil palm from Africa about 1848, chinchona for quinine in 1852, assam tea in 1873, and the Hevea Brasiliensis, a specie of rubber, from Brazil in 1883. Approximately thirty-five years of selection and breeding were necessary before quinine became important to the economy of the area and the same was true for rubber. The latter did not expand appreciably until after the first World War as shown in the production figure for 1914 of only 7500 tons[1], while in 1951 the total export was 756,933 tons[2].

The agriculture of the Indonesian farmer has always been and still is directed at the simple objective of producing sufficient food for his family. While rice is the primary food crop and most attention has been given to its production because of soil and climatic conditions, it is not the most important crop in all parts of the country. There are three areas with respect to primary food crops. The western part of the Archipelago, including Sumatra, Java, Kalimantan, and Sulawesi with approximately eighty percent (80%) of the total population, composes the rice area. Many areas in the southeastern section or Lesser Sunda Islands rely upon corn as their principal crop, because their severe dry season provides inadequate moisture

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1. Ibid., p. 294.
2. Ministries of Economic Affairs and Agriculture, Warta Ekonomi, op. cit., p. 193.

for even one crop of rice annually in some areas. Bali and Lombok are the exception to this generalization, but corn is far more important on these two islands and in East Java than in the areas to the west. Corn is also an important crop in South Sulawesi where a surplus is available for export to deficit food areas of other islands. The Moluccas have often been described as the area with a sago economy because there the sago palm is a source of most of the essentials of life except for proteins and vitamins. From an attempt to rationalize the reasons for the dual economy present in Indonesian agriculture, it is apparent that Europeans have developed a commercial type of agriculture with capital gain as its primary objective, whereas the agriculture developed by the indigenous population has had production of enough food for the farmer and his family as its primary and often its only objective.

The requirements for living in the tropical climate are simple when compared to the temperate zone. The essential requirement of shelter is protection from the rain except at the higher altitudes where the nights are cool. Similarly, clothing is unimportant from the standpoint of protection from the weather. There is little necessity for production or storage of food or feed crops where planting, cultivation, and harvesting may be concurrent operations throughout the year as is the case in many areas; on the other hand, the humid climate and high temperatures make the storage of foods and feeds very difficult except for short periods of time. Fruits and vegetables, either cultivated or wild, can be available throughout the year and may be supplemented by fish from the streams, lakes, and sea and by the game from the forests, with the result that people who are satisfied with a minimum level of subsistence only have to produce a minimum of field crops in order to sustain life. In the absence of consumer commodities, the result of a lack of industrial development and a lack of communications, there has been little incentive for the farmers to strive for greater production.

It is impossible to say whether the lack of development of more extensive agriculture or intensive agriculture in the Outer Provinces may be attributed to the above factors or whether they should be attributed to the inability of the farmer to cultivate larger areas because of the rapid encroachment of tropical vegetation on fields that have been cleared for cultivation. On Java the intensive agriculture that exists in undoubtedly the result of the increase in population; in 1860 the population of Java and Madura was placed at only five million[1], while the current estimates are fifty million people. It seems that the most plausible reason for a farm family to cultivate no more than two to three acres in the Outer Provinces is that in areas of ample

1. Vlekke, op. cit., p. 320.

rainfall no more than this amount can be kept clear by the farmer and his family with their primitive tools, and in areas having a severe dry monsoon no more than this amount can be adequately prepared for planting to permit crop growth under favorable conditions.

As previously stated, farmers enjoyed rights of land tenure rather than the Western concept of ownership in fee simple. Raffles' formal statement in 1813 was, in fact, only a measure that legalized an existing system and was not modified further until the Agrarian Law of 1870 was issued prohibiting anyone except Indonesians from owning land[1]. In view of the general concept that the Government owned all lands, the above regulation appears unnecessary, but when one realizes that the rights of occupation and use in many areas amounted to ownership by consent of the local government, that such ownership was of sufficient strength that the right of tenure could be passed on by inheritance, and that it could be mortgaged or sold, then the need of the regulation is apparent. The preceding statement is true in some areas, but in others upon the death of a farmer his land is returned to the control of the village for redistribution among the inhabitants of the village on the basis of need and ability to cultivate. Because of the subsistence level of farming, the farmers have always lived on the margin of emergency need for money

1. Ibid., p. 287.

or food, and because most of the retail trade, small industry, and money-lending has been and still is in the hands of the Chinese element of the population, without the law the Chinese would have become large landlords.

Because of the lack of collateral other than the land, the Indonesian farmer has been a poor credit risk, a condition which has enabled the money-lenders to charge such exhorbitant rates of interest as four to five hundred percent. However, because of the Indonesian sense of honor towards the repayment of debts once he became indebted, the farmer could never repay even a small debt and would not risk dishonor by refusing to pay the interest. This condition led to a circumvention of the law through the granting of a long-term lease to the money-lender in return for the cancellation of the debt, a device which actually enabled a farmer to become a tenant on his own land. Such leases were subject to review and cancellation by the Government unless certain minimum conditions were met, but again the sense of honor would often prevent the farmer from reporting the actual conditions of the lease to the Government.

In the highlands of West Central Sumatra where the Minangkabau tribes live, there exists a matriarchal system of property ownership and inheritance. Control of property passes from the mother to the oldest daughter who must distribute the income among the other daughters as long as they live in the family house. When a daughter marries, the husband comes to live with her family and to assist in working the family land. Upon the occasion of a marriage another room is constructed for the new family; as long as the daughter lives on the property, she shares in the income; the property itself is not divided. If the daughter and her husband move away, then she forfeits all property rights, and the income is distributed among the daughters who remain.

In Sumatra the right of occupation after land has been cleared is generally recognized, and since the first World War a class of land owners with large holdings compared with other Indonesian land owners has developed. The _ladang_ type of culture has typically been followed west of Palembang and north to Djambi. With the increased importance of rubber after the first World War the farmers began planting rubber trees in their _ladang_ fields with the second or third crop of rice. The fields were then permitted to return to brush and secondary forest vegetation, but the rubber trees could survive and grow at a slow rate. After a period of ten to twenty years the trees were large enough to tap, and the planters began either to collect the latex individually or to permit less enterprising individuals to make the collection on shares, usually without clearing the underbrush. The amount of rubber harvested throughout Sumatra from small holdings is dependent upon the price of rubber with relation to the price of rice. When the laborers or the farmers are able to earn enough money by working rubber to buy more rice than they can produce in their dry fields, they collect the latex; however, when the differential between the two changes materially, rubber is allowed to rest while the people work in their ladang.

In Kalimantan while travelling by boat through the swamps, the author occasionally saw a large tree near the streams, each with several beehives hanging from the limbs. Some of these trees were more than four feet in diameter at the base and were one hundred feet or more in height. Up the side of each "bee tree" was a ladder made by putting wooden pegs into the trees and fastening rattan to the pegs. Inquiry about these trees brought the answer that they were owned by the first man to find them and put a ladder up the trunk, and after ownership is once established it is passed on from father to son. Similarly, the right of ownership of land is established in this area by clearing land and placing it under cultivation. The chief of a village on the Kahajan River cleared an area of 75 acres between 1930 and 1935 near the river and constructed a levee around it for protection against the tidal backwaters and thus became, for this area, a large land owner. Although the land, because of inadequate irrigation, was not well adapted to rice culture as originally intended, its cultivation in cassava and other food crops is permitting a son to attend college in Holland. Many others have followed this same practice of planting rubber following ladang rice culture with the result that at the last accurate census of 1936-1937 there were 209,997 acres[1] in small rubber plantings. In contrast to Sumatra where there are many large rubber estates, in South Kalimantan which is the location of the largest rubber plantings of Kalimantan there are only three estates and one of these was established by the Government.

There is such a marked contrast in the rubber plantings of the farmers and those of the estates throughout Indonesia that one does not need to inquire as to whom a particular planting belongs. The plantings of the estates with their 120 trees per acre are either clean of underbrush and clean cultivated, or the land is covered with a leguminous green manure crop for the control of erosion and soil improvement. In contrast to the orchard-like appearance of the estates' rubber plantings those of the farmers look like an untended woodlot with their closely spaced 360 to 400 trees per acre, and the ground is so completely covered with underbrush that even passage on foot through the plantings is difficult. The difference in cultivation and attention to the rubber plantings is reflected in the difference in the yields as the average

1. H. J. Schopuys, Personal Communication, Nov. 1951.

estate yield is in the 1100 to 1300 pounds per acre per year range while that of the small-holder is usually below 650 pounds per acre. The quality of the latex from the estates is also generally higher than that of the farmers because of the absence of trash from the underbrush and the normal use of metal collecting cups in lieu of the half-coconut shells often used by the farmers. Differences in the quality of rubber are also due to differences in processing techniques and equipment that will be discussed more in detail later.

In Kalimantan's inland territory, sparsely occupied by the Dyak tribes, little agriculture has developed, and consequently the literature says little about land tenure or ownership. The Dyak tribes are described as hunters, fishermen, and traders with the tribe having communal rights to large areas and living in long-houses with enough rooms for every family of the tribe. In addition to the normal use of fish traps and nets as found throughout Indonesia, the Dyak people also use derris roots to facilitate taking large quantities of fish for drying. The derris roots, when thrown into the water, stun the fish and cause them to rise to the surface and float downstream where they are netted by men wading in the shallow streams or waiting in dug-out canoes in deeper waters. While this method of fishing is against the law, the Government is not yet able to enforce the law.

In Sulawesi, in the Moluccas, and in the Lesser Sunda Islands most of the lands have in recent centuries been claimed by the sultans and radjahs; however, as the influence of the Netherlands Indies Government in these areas increased, the local rulers often retained only relatively limited lands for their own use but also received annual allowances from the government. The lands were usually and in some places still are rented by these local rulers to the people for one-fourth to one-half of the crop. Because of the necessity of at least a period of transition from the ancient rule, the present Government has given the sultans and radjahs the title of Suapradjah with some administrative authority. The amount of authority and influence in the present day conditions seems to depend entirely upon the individuals who now occupy these positions. Some seem to have a great deal of influence and authority while that of others is nominal, whereas under the pre-war government they had almost complete autonomous authority within their territories.

Throughout Indonesia there is the strong influence of communal property rights and community effort in the primitive agriculture of the farmers. In the traditional concept the area surrounding a village or _desa_ is the property of the _desa_, and the areas for cultivation are allocated under the _adat_ of the particular section. In South Sumatra one finds the Marga, or village chief, with the authority

to allocate lands and such allocations are recognized for long periods of time; the same authority is reposed in the village council on Java; on Flores the allocation is made by the Tuan Besar who is a village elder but usually not the village chief. On Bali the communal system has perhaps attained its highest development with the control in the hands of the village council which reallocates land annually according to the needs of the individual and the community.

Because of the steep, rugged mountainous terrain of Bali it has been impractical for the farmers to construct the necessary irrigation canals individually. The traditional communal life of the Balinese resulted in the formation of many <u>subak</u> or agricultural cooperatives that function as water control boards supervising the construction and maintenance of irrigation works and the equitable distribution of available water. Covarrubias[1] describes these objectives of each <u>subak</u>: to insure that each farmer will receive enough water for his crops, to police the dams and channels effectively so that strangers may not divert water, to settle disputes, and to attend to the communal rice festivals. The <u>subak</u> had become the village authority for all matters pertaining to agriculture even before the Netherlands Indies Government subdued the Balinese early in the Twentieth Century, and it is through the <u>subak</u> that

1. Covarrubias, op. cit., pp. 70-87.

the various services of the new government are working today for the further improvement of Balinese agriculture.

The _subak_ operates under the direction of a group of elected headmen who conduct meetings, see that decisions and rules are carried out, impose fines and penalties, act as treasurers of the organization, and keep written records of the membership and proceedings. The officers of the _subak_ receive no pay but may receive extra allowances of water for their fields. Every man who owns rice fields must become a member of the _subak_ and, while he may pay others to actually perform his portion of the labor of construction or repairs of irrigation systems, he must be present when important repairs are made. At the shrine of agricultural dieties in the rice fields the _subak_ meets once a month or more often if necessary, and decisions are reached by a majority vote of the members who are subject to fines for absences which cannot be justified. The control of the _subak_ over the agriculture of its area even extends into the land tenure conditions because if the cooperative decides that a man holds more land than is beneficial to the community, then he must share the yields of the land with non-landowners who are assigned by the _subak_ to assist in its cultivation. The Balinese from _adat_ and religion observe many ceremonies and festivals. These customs are also present in the _subak_ where refreshments are served after each meeting, or if the _subak_ is very prosperous, the meeting is followed by a banquet.

Because rice is the important food crop of Indonesia, it is only natural that irrigation has been developed to a very high degree, and throughout the Archipelago the density of the population and the visible prosperity of people is in direct proportion to the availability of water and the development of irrigation. Although irrigation systems are primarily developed for the benefit of rice crops, supplemental crops such as beans, corn, sweet potatoes, and peanuts are often grown with the benefit of some irrigation, especially in those areas where the streams do not provide adequate supplies of water for rice during the dry monsoon. Gravity irrigation by diversion from the streams is almost the universal rule with irrigation by pumping found only in a few locations, and most of these are on the lands of the sugar estates in Central and East Java.

Previously East Java, the Lesser Sunda Islands, and South Sulawesi have been referred to as the area of Indonesia in which corn attains its most important position as a food and forage crop. The importance of corn in these islands as a food crop does not indicate that the people, because of any differences from those of Western Indonesia in their dietary habits, find corn more delectable than rice; instead, it is a reflection of the four months' rainy season and the following eight months' dry monsoon that in some areas leaves almost a desert condition in its wake and prevents large-scale rice production. In these areas of an extended dry season the houses of the people are the poorest, the gardens of the kampongs the most sparse, the fields the least developed, and the people themselves the poorest in appearance of all of Indonesia seen by the author. It is not attributable to any ethnological or other difference except the fact that there is insufficient water to support any well developed culture of people or agriculture until modern science can tap undeveloped groundwater supplies or adapt dry farming techniques to improve conditions.

The agriculture of the islands of Sumbawa, Flores, and Sumba is the most primitive that the author has seen. The culture of crops with the broad hoe is generally considered to date back at least five hundred years, but preparation of land prior to planting with sharpened sticks is common on these three islands, especially on Flores and Sumba. It is questionable as to what age in history stick preparation of land should be placed. The usual method of land preparation is that towards the end of the dry season the alang-alang grass is burned off and the land is turned by using sharpened sticks as dibbles (Fig. 28). As the men and women work together, three or more people line up and punch the sharpened poles into the soil at fifteen to eighteen inch intervals, and when the dibbles have penetrated to a depth of about twelve inches, the soil is prized

Figure 28. Land preparation with dibble sticks on Flores

Figure 29. Poor condition of the soil after preparation with dibble sticks Photo courtesy Abdul Rachman.

over in lumps generally six by twelve by thirty inches in size and is left in the resultant rough condition (Fig. 29), until the rainy season begins when rice or corn or both are planted. The rain tends to dissolve the lumps of very heavy soil, and in areas where the rainy season is usually of sufficient duration for a rice crop to mature, rice seed is planted; if the usual length of rainy season is too short for rice to mature, then corn is planted, but it is not uncommon to see rice growing between the clods and corn on top of them. The planting is accomplished by the simple but labor requiring technique of punching with sticks small holes in the soil where the seed are placed and then covering the seed by hand. The work of punching the holes is usually the work of the men, while placing the seed and covering them is the work of the women and children.

There are several basic factors contributing to the lack of development of agriculture in these southeastern islands. As described previously in the discussion of the soils and climate of the Archipelago, few soils of high fertility have developed because of the nature of the parent material, the topography of the land, and the unfavorable climate. The semi-nomadic tribes have been dependent upon their livestock plus the fruits, vegetables, and game of the forest for their livelihood. Even today as one rides along the roads, it is common to see the men carrying their bows and arrows or spears with which to kill deer, wild boar, or other game. During the rainy season many of the streams which rise in the mountains disappear before reaching the coast, and only a few small streams have a year round flow. The people are still animistic in their religion; only in relatively recent years has it been safe for outsiders, whether Western or Eastern peoples, to enter and attempt to introduce any change. Land preparation with sticks was observed on Flores and Sumba in 1952 when there were large numbers of cattle, horses, and water buffalo grazing on nearby grasslands, and while a few cattle or buffalo are used for plowing, the majority of people do not know how to use animal power in their work. Furthermore, it was stated that the people do not want to own livestock for their draft power or their monetary value if sold but only for the social standing they acquire through the ownership. Those who own numbers of livestock are considered the leading citizens and in payment for the communal effort of the village in preparing land, in planting or harvesting a crop, or in the observance of marriages, funerals, and other festive occasions give feasts for the surrounding countryside for which many cattle or buffalo are slaughtered, but much of the meat is wasted because of inability to store it for future use.

In the eastern islands, as in other parts of Indonesia, horses are used for riding, for pack animals, or for pulling small carts; never are they used for plowing or for the cultivation of crops. Because of the lack of roads horses are ridden or used as pack animals much more commonly than in the more developed islands. On each of the islands of Sumba, Flores, and Sumbawa there is a main road running generally east and west, from end to end, but there are no roads worthy of the name from north to south, and areas a short distance away from the axial roads are inaccessible except by foot or on horseback. The problems of transportation coupled with the numerous languages of the islands which are often mutually unintelligible have served as a major hindrance in the development of the islands as have the tribal wars which continue even today in the more remote areas.

Under the conditions on the eastern islands corn has become the staple crop and is usually planted at the beginning of the wet season. The varieties used are the dwarf varieties that mature in ninety to one hundred days with a yield usually estimated at nine to twelve bushels per acre. From Bali and Lombok there is a small surplus of rice and corn in addition to some copra, coffee, cattle, swine, and all-spice produced for export to other islands and abroad. From Sumbawa and Sumba only livestock is exported in measurable quantities, and from Flores there is some copra production in the vicinity of Ende on the south coast and near Maumere on the north coast. From both of these last named towns ships of the Koninklijke

Paketvaart Maatschappij call at three to four weeks' intervals and about 1000 tons of copra are exported to Surabaja and Macassar monthly. Livestock is exported from Sumba as permitted by shipping space; late in 1952 the allocation of shipping space was 800 animal units per month with the small horse as the basic unit. A carabao was considered as 1.7 animal units, while a cow (Brahma type) was considered as 1.4 animal units.

On Flores the Catholic missionaries of the Order of the Divine Word[1] are attempting to introduce agricultural improvements as demonstrations for the people while at the same time producing the food and feed crops required for the Mission establishments. There are an estimated 150 missionaries on Flores who maintain churches, elementary schools, trade schools for woodwork, metal work, and printing, and their religious seminaries. At the school and seminary at Todabelu a dairy herd of Friesian type cattle provides a portion of the milk and cheese needed at this and other establishments, and there is also a herd of swine of the Hampshire and Chester White breeds. The sires of these herds are used for breeding with the native livestock of the people and should result in improvement, in a limited area, within a few years. At Ruteng, Todabelu, Maumere, and Hokeng the Mission has developed fields for the production of food crops such as corn, cassava, sweet

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1. Father J. C. Van Doormaal, Personal Communication, Nov. 22, 1952.

potatoes, and beans and on the high lands of Todabelu is producing a small quantity of wheat. For the purposes of demonstration and for supplementing the income of the Mission, there are 50 acres of coffee arabica at Todabelu and 285 acres of coffee robusta at Hokeng. In addition to these pre-war planting, since the war the Mission has taken over the concession of a former estate at Nangahale and now has approximately 500 acres in coconuts for copra.

In the area of Todabelu the Mission, in addition to farming its own land, is renting additional land from the people by one of two methods. The Mission uses the land of the people and after a period of ten years is to return the land in adequately shaded, bearing coffee. By this method the Mission has the clear use of the land for three to four years, at which time lamtoro and dadap must be planted, but crops may be planted between these tree plantings until the end of the sixth year, at which time the coffee is planted. The second method by which the Mission rents land is by the preparation of the land with a tractor and disc harrow; for payment the Mission plants and cultivates one-half of the prepared area for its own use. In addition to using tractors for their own use and in payment for the preparation of rented lands, the Mission is doing some custom work for the people at the rate of $5.00 per acre at Todabelu and $3.35 per acre in the vicinity of Hokeng and Nangahale where the soils are lighter. It is also worthy of note that the Radjah of Maumere has purchased a small tractor of German manufacture (30 brake HP) and is preparing land in the vicinity for $3.35 per acre where one plowing and one harrowing seem adequate on the light soils.

Related to the inability of the people to cultivate more land on Flores, Sumba, Sumbawa, and Timor is the necessity of constructing fences around the cultivated fields of prevent damage by both domestic and wild animals. Formerly most of the fences were constructed from bamboo or the saplings from the burned over ladang, but at the encouragement of the agricultural advisors and missionaries most of the fences are now from lamtoro and dadap planted as close together as possible to establish permanent living fences strong enough to keep out the wild boar and wild carabao, as well as the domesticated stock. It was estimated by Father Van Doormal and others that there were 30,000 banteng or wild carabao on Flores alone in 1952. In some of the very rocky areas such as are seen in the vicinity of Melilo in East Sumba, the fields are partially cleared of the cavernous limestone which is used for fence construction. In a few areas fences of sod and stone are used.

Previously reference has been made to the sago economy of the Moluccas. The climate of the Moluccas (Stations 29-34; Table III) results in tropical rain forest almost

throughout the islands, and as the income from species grown in the forest has usually provided income for the purchase of food and other essentials from other islands, there has been little inclination to improve agriculture. There also seems to be a general disinclination towards the difficult field work of farming with primitive tools according to comments of several Ambonese acquaintances of the author. Perhaps this lack of desire for farming was accentuated by the high regard of the Dutch for the Ambonese people as mercenary troops and the position of rank and respect that many of them attained in the Netherlands Indies Army. Because of the remoteness of the Moluccas from the rest of Indonesia and its importance as a naval base, the Moslem influence was never strong; most of the people are Christians or Animists with most of the Ambonese especially professing the Christian faith. One Ambonese described his people as excellent soldiers, excellent preachers, and excellent teachers but very poor farmers.

Under the existing conditions the people of the Moluccas have always relied upon the sago palm and fish as the principal food items in their diet. In addition to its value as a source of food the heavy stems of the sago palm fronds furnish a very satisfactory building material commonly used for the walls of native homes, and the coarse fiber which grows between the fronds and the trunk is the traditional material used in the thatched roofs of the area.

Because of its exemplification of the area adat, the economy of its use, and its availability, the sago palm material was used in the construction of the office of the Governor of the Moluccas and his administrative assistants in Ambon as shown in Figures 30 and 31.

The only other area of Indonesia where the sago palm has ever been of appreciable importance has been on the small islands lying off the coast of West Central Sumatra. On these islands the sago palm has also been the most important source of food except for fish and has also furnished the principal material of construction.

If one attempts to summarize the development of Indonesian agriculture to its present stage, he can only say that it remains a study in contrasts. Some areas have progressed along with agricultural science so that production and processing methods are among the most modern in the world, except for the substitution of animal and man power for machinery because of the relatively high cost of machinery in the Archipelago, while other areas have made virtually no advancement in the past five hundred years. All stages of development are found between these extremes; it is only from the favorable conditions of climate and soils that the population has been able to produce enough food to prevent visible famine. The possibility of improvement of Indonesia's present agriculture, with few exceptions, offers almost unlimited opportunities for

Figure 30. Sago palm frond ribs used as vertical siding in wall construction in Provincial Administrative Office Building in Ambon

Figure 31. Indigenous type of home constructed of sago material on Amboina

increases in production so that many years will be required before the potential productivity of the country is approached.

CHAPTER IX

PRINCIPAL FOOD CROPS

A. General Agronomic Factors

In the economy of the Indonesian farmer, in the economy of the nation, and in the diet and traditions of the people, the crop of greatest importance is rice. It is almost impossible for a person from the United States to realize that a subsistence food crop can have such importance. The primary goal of the Indonesian farmer is the production of enough rice for himself and family in contrast to the concept of the farmer in the United States who usually considers food production incidental to the production of commodities for market. It is also very difficult for one from the United States to become accustomed to any one food being of such importance in the diet of even a few people, much less the major constituent in the diet of the entire population which equals approximately half that of the United States.

The annual per capita consumption of rice in Indonesia is slightly less than two hundred pounds compared to only six pounds per capita in the United States. In the typical Indonesian diet bread and potatoes are almost completely absent but rice is eaten at every meal. Rice is prepared in many ways; however, boiled or steamed rice is normally served at noon and in the evening and fried rice - boiled rice fried in coconut oil with soya sauce and other seasonings - is most common at the morning meal. Perhaps the Indonesian attitude towards rice is best described in the expression belum makan nasi, belum makan , which translated literally means "if I have not yet eaten rice, I have not yet eaten". The above remarks should not be interpreted to mean that the Indonesian people eat nothing except rice, although this is almost true with the poorest people; with rice a variety of meats, fish, and vegetables is served, all of which are very hot from the use of red pepper.

The annual requirement of rice in Indonesia is estimated at 7.7 million short tons, of which approximately 10 percent was imported in 1952. As a percentage factor this does not seem great, but when one considers that this 10 percent represents an expenditure of approximately 140 million dollars or equivalent in foreign exchange, its importance to the national economy is apparent.

Because statistics of the above magnitudes are difficult to visualize, perhaps it is advisable to give the requirements of a family and to compare the requirements of a family with the productive capacity of a farm family. A young official of the Ministry of Agriculture stated that he usually purchased 115 to 135 pounds of rice per month, the exact amount varying with the number of guests eating with him during the month. In this household there are the official, his wife, three small children, the mother-in-law,

and two servants. This household, which is about average in size, requires approximately two-thirds of a ton of rice per year -- the production of 1.75 acres of irrigated rice or 3.5 acres of upland rice. When the area required to produce the food for a family is compared with the area cultivated by a farm family, it is obvious then that the average farm family is barely able to produce enough rice for its own needs. On Java and Madura the average farming unit is 1.75 acres, while in the Outer Provinces the farming unit varies from 2.5 to 5.0 acres. On Java and Madura there are less than 1.25 acres of irrigated land per farming unit and in the Outer Provinces much less.

The existing conditions were very aptly described by another official of the Ministry of Agriculture when he stated that the average farming unit was too small to provide an adequate standard of living but too large to permit starvation. If weather conditions are favorable, if flood damage is not serious, and if rodents, insects, or diseases are average, the farmer is able to produce enough food for himself and family. If any of these factors affecting production are unfavorable, there is an inadequate food supply which increases the farmers' susceptibility to borrow money or rice from the money lenders whose usurious rates of interest make repayment almost impossible. The importance of traditional feasts in honor of religious occasions or events of special importance in the family life have often prevented farmers from accumulating any surplus, and it is often the case that they are the direct cause for borrowing.

Under the above circumstances the economic condition of the farm family is directly related to the production of rice wherever the combination of climate, topography, and soils permits its culture. In the less desirable areas, from the Indonesian viewpoint, where rice production is not practical in the dry-monsoon because of the lack of irrigation water and in the areas where rice production is very limited even in the wet monsoon, secondary food crops such as cassava, corn, peanuts, soybeans, and pigeon peas gain importance. The Indonesians leave little doubt when discussing food crops that these crops are of secondary importance and will receive attention only when rice culture is impractical.

In a few small areas adjacent to the large cities or harbors, vegetable and fruit production is of major importance. Except in these areas where good markets exist, fruit production is primarily for home consumption and along with vegetable production receives little attention. The vegetables usually eaten by the farm people come from the leaves, shoots, and tubers of the native flora more often than from cultivated gardens; however, many of the vegetables commonly known in the United States are found in the markets of all the cities.

Fruit production is habitual around the home of almost every Indonesian farmer, and from the fruit trees shading the farm yard there is an almost constant supply of bananas, papaya, coconuts, and the breadfuits. In addition to these there are areas where pineapple, citrus fruits, mangosteen, rambutan, and salak are cultivated for home use and also provide a surplus for the market. In a few areas adjacent to the large cities fruit is produced primarily for market, but in the overall agricultural economy these areas are far behind the rice producing areas in importance. The extent of areas cultivated in the principle food crops and the total yields are given in Table IV.

B. Rice

Most of the rice of Indonesia is grown during the wet or west monsoon when the requirement for irrigation water is at a minimum. In those areas where there is adequate water available from the streams for irrigation, rice is often planted without regard for season and it is possible to produce five crops in two years. Because there are few areas where the water supply is adequate for all the cultivated land to be irrigated, other crops are planted on some of the sawah, especially during the dry monsoon. It has been stated by Van De Goor[1] that, because of the heavy

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1. G. A. W. Van De Goor, Rice Cultivation in Indonesia, Gen. Agr. Exp. Sta., Bogor, Indonesia, Mimeographed, 6 pp.

TABLE IV

AREA AND YIELD OF PRINCIPAL FOOD CROPS[1]

Crop	1940		1950		1951		1952		1953 (estimates)	
	Area[2]	Yield[3]	Area	Yield	Area	Yield	Area	Yield	Area	Yield
Rice, irr.[4]	9,620	9,960	12,050	10,880	12,900	12,280	13,080	12,657	13,280	13,350
Rice, dry[4]	962	584	2,865	1,274	3,090	1,372	3,140	1,461	3,400	1,588
Corn	5,060	2,175	7,040	2,508	7,410	2,640	7,980	2,912	8,150	2,984
Cassava	2,600	10,055	2,335	8,200	2,470	8,680	2,580	9,050	2,605	9,165
S. potato	588	1,740	544	1,518	569	1,588	583	1,630	265	1,672
Peanuts	627	228	734	257	753	266	815	268	852	280
Soybeans	1,060	338	906	281	1,032	315	1,060	309	1,078	314

1. R. Soetijo, Almanak Pertanian 1953, Kementerian Pertanian, Djakarta, November 1952, p. 343.
2. Area in 1,000 acres.
3. Yield in 1,000 short tons.
4. Rice yield is in terms of stalk padi or approximately twice the head rice yield.

rainfall of the wet monsoon, most of the plant nutrients have been leached from the topsoil and lie below the roots of most annual plants. To this condition he attributed the development of the system of under water preparation of the soil that is common throughout the monsoon areas of the Far East. This method of preparation puddles the topsoil and tends to minimize further leaching and has proven to be the most satisfactory method of land preparation for rice. In order to maintain the puddled condition of the soil throughout the growing season, the farmer must have large quantities of water either from rainfall or from irrigation.

Irrigated rice fields are classified by their source of water which may be from the technical irrigation systems, from the primitive irrigation systems, from rainfall only, or from rainfall and residual flood waters as in the <u>lebak</u> culture. In the areas of the technical irrigation systems, the concrete diversion dams, weirs, sluices, and other control structures as well designed in accordance with hydrologic data available, and very detailed irrigation schedules are followed. For example, the total area of an irrigation system often is divided into three or four parts. At the beginning of the wet monsoon the first subdivision will receive enough water to permit preparation and planting of its nursery beds and to start preparation of its fields before other subdivisions. As the rainfall increases, some water is supplied to the second subdivision for its nursery beds and fields; after transplanting is completed in the first subdivision, its allocation of water is reduced so that the allocation to other areas may be increased to permit the establishment of nursery beds and the preparation of the soil for transplanting. On some soils the requirement of water for the preparation amounts to as much as 30 percent of the total required.

Rice fields are classified as _sawah_ if they are irrigated from either primitive or technical irrigation systems, rain _sawah_ (_sawah tadahan_) if dependent upon rainfall, or dry fields (_ladang_ or _tegalan_) if unterraced and unirrigated. The irrigated fields are terraced with bench type terraces with the horizontal and the vertical spacings dependent upon the slope of the land. The terrace ridges are usually no more than a foot in width and are of sufficient height to retain water above them to a depth of perhaps six inches, seldom more and often less. The area between terraces has, through trial and error of many years of cultivation, been leveled by the use of broad hoes and hand labor. In some of the mountainous areas the vertical wall of the terrace bank is as high as, or higher than the width of the level area above. This condition is especially true on Java and Bali where the density of population has made it necessary to cultivate every possible square foot of land; indeed, some of the terraces have little more than one square yard of land above them for cultivation but these are cared for just as meticulously as the larger areas (Figure 32).

The upland or dry rice fields are not terraced, nor has any attempt usually been made to contour planting for moisture conservation or erosion control. Until recently all terracing has been done only for water control, and any erosion control that resulted has been incidental. In general, all terracing has been accomplished, as stated above, by trial and error with water indicating errors of judgement. Surveys are uncommon and there are no recommendations available for the spacing of terraces. The farmer constructs the benches by digging the soil away from the upper side of the horizontal area and moving it to the lower side with his broad hoe; after the area is flooded, further digging and earthmoving by hand make the necessary changes as shown by the water level.

The irrigated fields are usually prepared for transplanting while saturated or more often while under water. In fields where irrigation is possible, the fields are flooded before plowing; on the rain dependent fields the preparation is delayed until after the wet monsoon has begun. The fields are alternately plowed and harrowed if the farmer owns livestock, or they are dug thoroughly two or three times with the broad hoe if the farmer must prepare his fields without animal power. The plow used is normally made locally from wood, although iron points are common in

Figure 32. Cattle and wooden harrow used for underwater preparation of small terrace area for rice

Figure 33. Dry land preparation with oxen and tapered cylinder wooden plow bottom

many areas. The plow bottom may be only a tapered wooden cylinder (Figure 33), usually about four inches in diameter and two feet long with the taper from about the midpoint, or it may have almost the same shape as the conventional steel bottom moldboard plow (Figure 34) so common on American farms. A few steel bottom plows are made in Indonesia, and a few have been imported annually for many years but their use has never been widespread. The shape of the bottoms is such that little turning of the soil is accomplished; rather there is a lateral pushing action resulting in heavy draft even when plowing at very shallow depths. Carabao or cattle are the draft animals used in the fields; the many small horses are used only as pack animals or to pull carts on the roads.

In a few areas, particularly on the islands of Sumba and Sumbawa, land preparation is accomplished by restricting herds of carabao or cattle to the flooded fields and driving them around until the vegetation is trampled into the mud and the soil is well puddled.

After having been plowed, the land is usually harrowed under water to break up the clods and to smooth the surface prior to transplanting. The harrow commonly consists of a single cross beam from which wooden pegs extend downward six to eight inches (Figure 32), but a few steel harrows of the same general type are used. The beam extends to the rear about two feet and is used alternately as a lever,

Figure 34. Dry land preparation with steel pointed plow bottom

Figure 35. Blacksmiths making a tajak in Negara, Kalimantan shop

with which the operator lifts the harrow to pass over the mud that piles up in front of the beam or on which he applies his weight to obtain greater penetration. If the farmer must prepare his land with a hoe, after he has dug his way through the field, he goes over it again either with the hoe or with a heavy stick and breaks up the clods.

In answer to the author's questions, farmers and agricultural workers throughout Indonesia indicate that land is usually plowed and harrowed three times before the preparation is considered adequate. The same is true for dry land when livestock is used. More often, however, the farmer cultivating the non-irrigated soils does not own livestock and must prepare the land with the hoe. When land is prepared with the hoe, the digging is usually preceded by fire to eliminate as much of the vegetation as possible; the land is then dug up and the clods are broken either with the hoe or a stick. In the areas where the shifting or ladang culture is common there often is no preparation of the soil after burning but on Sumba, Flores, and Sumbawa the dibble sticks are commonly used in preparing the land for rice or corn.

In the vicinity of Bandjarmasin, Kalimantan the Band-jarese people who do not own cattle or carabao use the tajak (Figure 35) in the preparation of their ladang fields. The tajak is a scythe shaped implement with a handle about 3.5 feet long; it is peculiar in that its cutting edge is on the convex side of its curving blade. In order to prepare their grassy, organic soils, they do not turn the soil but simply loosen the surface by cutting the grass with the tajak. The grass is cut one to two inches below the surface of the soil and is removed for compost; the soil receives no further preparation prior to being planted in dry rice, corn, or other crops.

Swamp rice culture is also found in the Bandjarese territory. In parts of this area large tracts of land are flooded annually throughout the west monsoon. In these areas the variety of rice used is one that will withstand numerous transplantings and requires about eight months to mature. After being started in nurseries, the rice is transplanted in areas of shallow water and is subsequently transplanted several times as the flood waters recede in the east monsoon. The number of transplantings for this variety of rice is regulated by the recession rate of the flood waters; usually it is moved three to four times before reaching maturity, and although the labor requirement is great, this culture is common and is indicative of the Indonesian farmers' desire to produce rice wherever possible.

The labor required for land preparation varies from about forty man-hours and eighty animal-hours per acre for the preparation of flooded fields to about four hundred man-hours per acre for the hoe preparation where alang-alang (*Imperata cylindrica*) must be destroyed. No estimates are available for the labor required for the stick culture.

For irrigated rice, seed are planted in nursery beds and generally are transplanted to the fields at the age of six to seven weeks. In the areas of the lebak culture of South Sumatra the nursery beds may be a mixture of soil and stable compost six to eight inches in depth on a floating bamboo raft, or they may be on a high terrace bank along the river. All nursery beds are located so that they may receive adequate water, and many in South Kalimantan are on the banks of the canals and rivers where they can be watered daily. Under the ladang culture the seed are usually planted directly in the field in small holes opened with a stick used as a punch. The seed are carefully placed in the holes and covered by hand. Where the ladang follows forest growth, there often is no preparation of the seed bed. In this type of ladang (Figure 36) and in the stick culture of Sumba and Flores corn is often interplanted with rice. Behind the forest the interplanting of rice and corn follows no definite pattern, but where land is prepared with sticks, corn is planted on top of the huge clods while rice is planted in the low places between the clods.

Balinese rice culture differs from other Indonesian rice culture; it is much more closely associated with the Hindu religion. Before work is begun in the rice fields, a small amount of water is brought from the holy sources

Figure 36. Mixed planting of rice and corn in
ladang on Kalimantan

Figure 37. Community rice harvest on Bali

of the mountains, and after a feast at the subak shrine the holy water is sprinkled over the fields and into the common irrigation supply canal so that all of the lands and waters will be blessed. Afterwards nursery plots are prepared and planted with due observance for the proper day selected from a religious calendar, and during the six weeks before the plants are ready for transplanting, the fields are plowed and harrowed with livestock and wooden implements. At the time of transplanting the owner must plant the first nine plants according to a fixed pattern in the upper left hand corner of the field as he faces the highest mountains in the area -- the residence of the gods. The remaining plants are set in the fields at a spacing of a hand span, sometimes by the farmer's family and at other times through communal effort; if the planting is done by communal effort, the owner usually pays for the labor by giving a feast for all of those assisting. The feast is accompanied by offerings and is supposed to further insure good yields. Offerings are also made soon after transplanting to prevent damage from insects, diseases, and mice; after seven weeks, more offerings are prepared for the feast day of the crop. Again at the time the crop is maturing or, according to the Balinese, is pregnant[1], offerings are made and still more elaborate offerings are prepared at the time of and after the harvest.

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1. Covarrubias, op. cit., p. 77.

In contrast to lack of cultivation of rice and other small grains in the United States, all rice in this country is cultivated, or it is more accurate to say that it is weeded from two to four times. In limited areas push type cultivators are used, and these stir the soil to a minor degree and submerge the weeds. Most of the weeding is entirely a hand and foot procedure. Usually the women and children go through the field pulling the largest, most harmful weeds and pile them on the terrace banks, but the small weeds are buried in the mud by the simple expedient of mashing them down with the feet. As the rice begins to flower, scarecrows usually appear, and shortly thereafter a small shelter on bamboo stilts is erected. The shelters consist of a floor of hamboo strips protected from the sun and rain by a thatch roof and usually are no larger than six feet square. From the shelter a network of strings runs over the fields to many bamboo poles, and from the strings are dried palm fronds or any other material which will rattle when moved. From the time the grain reaches the dough stage, someone is in the shelter during daylight hours watching for birds; when the birds appear, the strings are pulled and the birds frightened away.

Rice harvest time in Indonesia is festival time and also the time for what may be considered a share-the-wealth plan. The harvest is generally a community affair (Figure 37) with the people of the village assisting in the harvest and receiving a share, varying according to various local customs from one-fifth to one-eighth, of what they harvest in payment for their work. Because of the irregular times at which the crops are planted in many areas, this is a means of lengthening the harvest period as part of their crop is harvested every few days over a long period of time as a result of trading labor. Because of this method of harvesting and of paying for labor, the rice produced is distributed through the village and minimizes the need for large storage structures, and the work of spreading the grain in the sun daily until dry enough for storage is well distributed among the people of the village.

The inefficient method of harvesting has another social aspect that may cause difficulty in the introduction of more efficient methods of harvesting. In every village there are landless laborers who normally receive most of their wages in rice and who probably would form that class of people who in other countries would be dependent upon some form of relief. After the harvest they are permitted and are expected to become the gleaners who go over the fields looking for the stalks of grain that are left, accidentally or deliberately. Through this scavenging type of harvest these people are saving food that would otherwise be wasted, and as they obtain it through their own efforts, there is no stigma of charity attached to it. In the author's travels throughout most of the Archipelago the *ani-ani* knives have been the only tools used in rice harvest (Figure 38). The sickle is sometimes used to harvest rice straw after the grain has been cut, and it is reported that the sickle is used for rice harvest in North Sumatra and in North Sulawesi with considerable saving of labor, but the use of the sickle is not yet widespread.

In spite of the skill of the people in the use of the *ani-ani* knife the amount of labor required for the rice harvest is great. After observing the rice harvest on Bali and inquiring of the farmers the time required, the author calculated the labor to be 400 to 600 man-hours per acre, not including the labor to carry the *padi* to the village approximately a half-mile from the field. In discussions with agricultural officials since making the above calculations, they considered this a reasonable estimate of the harvest labor required.

After the rice is harvested and carried to the village, it is spread in the sun to dry, daily for periods up to three weeks. It is the work of the women to carry the grain from the house and to spread it on the road shoulders, on open grassy places, on the bannisters and abutments of bridges, or in the yards in order that it may dry. It is the work of the children to see that birds and chickens do not eat the rice. It is quite common to see mats woven from swamp grasses placed on the ground to prevent the loss of grains of rice but use of mats is not universal. The

Figure 38. Ani-ani knife used for harvesting rice

Figure 39. Traditional Minangkabau, Sumatra type rice lumbung

rice is ordinarily left in the padi form and is pounded out to meet the daily needs of the family.

When the rice is dry enough to remain in storage continuously, it is placed in grain bins or lumbungs. The lumbung usually has a wooden frame but it may be of bamboo. Its floor normally is from split pieces of the large bamboo, while the walls are woven from thinner strips of bamboo and the roof is of thatched material. Throughout most of Indonesia the shape of the lumbung is that of an inverted truncated pyramid (Figure 39), but in the Batak Highlands circular bins (Figure 40) from woven bamboo are common. In the Batak Highlands it is also common for rice to be threshed before storage as rough rice or padi gaba.

Mechanized rice production as it is known in the United States is unknown in Indonesia. However, in 1950 and 1951 the Deli Corporation (N.V. Deli Maatschape) with Indonesian headquarters at Medan, North Sumatra, undertook mechanized rice production on a limited scale and in a desultory manner but with results which, while not indicative of great success, cannot be considered a total failure. The primary interest of this corporation is in the production of the famous Sumatra wrapper tobacco which demands a premium on the world market, but the Corporation also has large concessions producing rubber, sisal, and palm oil. The production and processing of agricultural products by the Corporation requires hundreds of laborers who, under present

Figure 40. Cylindrical rice lumbung woven from bamboo

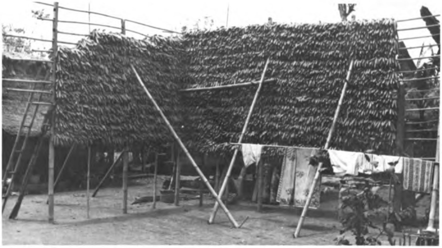

Figure 41. Corn stored on bamboo rack on Bali

Government regulations, must be sold rice by the Corporation at a fixed price, usually below that of rice in the free market. The amount of rice that a laborer is entitled to purchase from the Corporation is proportionate to the size of his family and amounts to an invisible wage paid by the employer and, where hundreds of employees are involved, amounts to a considerable expense. Because of its requirements for rice and the fact that North Sumatra since the war has been a rice deficient area, making the expenses and supplies dependent upon imports highly variable both in quantity and price, the Corporation initiated a project for completely mechanized rice production in 1950.

In 1950 the land preparation, seeding, and a part of the cultivation were accomplished with machinery, but the harvest was by hand because the two combines ordered for the purpose did not arrive until November 1951. The initial operation which was only on a few acres was said to be reasonably successful, but the second year's operations were successful in areas of new plantings but were partial to complete failures on areas which were in rice the previous year. Land preparation was accomplished with plows and harrows; seeding was performed with a 7 x 17 grain drill with alternate tubes plugged so that the drill planted nine rows at fourteen-inch intervals. The rice was cultivated three times with diamond points and sweeps on tractor mounted cultivators on a portion of the area but only twice in other portions because of too much rainfall at the time the crop was small enough to permit cultivation.

In the area of the second year planting the crop was a failure because of competition from weeds except on 15 acres which were weeded by hand, an operation which required about four man-days per acre. On the 165 acres planted in rice for the first time the competition from weeds was not such a serious problem. This area similarly was cultivated three times where weather permitted, but higher yields probably would have been obtained had the weeds in the rows been eradicated either by hand or by machinery. In spite of the fact that oil palm seedlings were planted in this area and made it impossible to plant two foot strips at twenty-five foot intervals, the estimated milled rice yield of 1680 pounds per acre exceeded the average upland rice yield of 1100 pounds per acre for Indonesia. This area was fertilized at the rate of 180 pounds of double superphosphate per acre, another factor contributing to the high yield probably was the better than average seed bed preparation. In the absence of experimental design adapted to statistical analysis, any specific conclusions are conjecture only, but the cost of production of approximately nine cents per pounds, roughly the equivalent of free market price, indicates the economic feasibility of mechanized rice production even though the initial cost of machinery is roughly twice that in the United States and

the cost of machinery maintenance probably is in the same proportion because of the cost of delivery and the import duties which must be paid upon entry into Indonesia.

Limited observations in relation to this mechanized rice production indicate that, before mechanized rice production can progress very far, experimental work must be conducted to obtain varieties of rice adapted to mechanical culture and harvesting, and techniques of utilizing existing machinery or new machinery must be developed for Indonesian soil and climatic conditions. One of the greatest problems, if not the greatest problem, in the field operation will be the elimination of the weeds in the rows, but this may be overcome by the use of rotary hoes, rod weeders, blockers, or perhaps by chemicals. If the field operations are successful, then will come the problem of adequately drying and storing the rough rice -- the same problem encountered by the farmers of the United States with the increased use of mechanical harvesters for rice, corn, and other grain crops. It would appear relatively easy to transplant American rice drying and storage methods and equipment to Indonesia, but here again one would be faced with the cost of transporting equipment half way around the world and the absence of qualified personnel to set it up and operate it on arrival. This development, as is true with many others, must progress slowly until qualified personnel can be trained within Indonesia to fulfill most of the country's need.

C. Corn

The culture of corn on most of the islands of Indonesia has advanced little, if any, in the past five hundred years; indeed, in some areas the only possible advancement that could be claimed since the introduction of the crop through various routes from the Americas is the substitution of hoes or knoves made of iron instead of bone or stone, and as stated in the description of rice culture, hoes and knives are not yet used in some parts of Flores and Sumba. Corn is a secondary food crop throughout the Archipelago and is planted only when conditions are unfavorable for rice production, and under these conditions it is of less importance than cassava from the standpoint of quantity produced. In 1952 on Java and Madura, 5,467,500 acres[1] of corn were harvested, on which the yields are variously estimated from seven to eleven bushels per acre according to the report of Melhus and Jackson[2], but with a reported total yield of 1,985,500 short tons[1]. The estimated area and yields for 1953 are 7,500,000 acres and 2,200,000 short tons.

Except in East Java and Madura, corn is usually planted during the dry monsoon where irrigation facilities are insufficient to permit rice production, but in these areas

1. Soetijo, op. cit., p. 343.
2. Irving W. Melhus and Robert I. Jackson, Corn Production in Indonesia, Gen. Agr. Exp. Sta., Bogor, Indonesia, Mimeographed, p. 7.

it is often planted during the wet monsoon because there is insufficient rainfall for rice even at this time. Because of the severity and length of the dry monsoon in the Lesser Sunda Islands and South Sulawesi, corn is of more importance than elsewhere; however, specific information as to areas planted are not available in published statistics. In all of the Outer Provinces, however, the ratio of rice to corn is approximately 2.0 to 1.0 as compared with a ratio of 2.5 to 1.0 for Java and Madura. On irrigated fields corn often follows rice during the dry monsoon, and there still remains enough time for a cover crop of weeds or a planted green manure crop to grow before time to prepare the land for rice again because the varieties of corn planted are the dwarf type which mature in 80 to 120 days with the varieties which mature in less than 100 days more common. The average ear of corn is about 1½ inches in diameter and 4 to 6 inches in length; the dwarf varieties have smaller ears than most of the sweet corn grown in the United States.

In the vicinity of Asembagus in East Java, where corn is planted in the wet monsoon on unirrigated fields, the practice is to plant the corn as soon as there is enough moisture to permit germination and as soon as the crop is mature to replant. It is stated that in this area the first crop averages seven to nine bushels per acre and the second crop less than six bushels per acre if the dry monsoon does

not begin too soon, in which case the crop is a total failure.

Land preparation for corn is at best inadequate in that the soil is plowed to a depth of no more than three inches when the farmer has livestock. More commonly the surface of the soil is disturbed with a hoe just enough to kill the weeds and the seed is planted. Fertilizers are seldom used, and turning under of leguminous cover crops occurs only in rare instances. In most of the corn observed one gets the impression that the farmer planted more seed than necessary in order to insure a good stand and did not bother to remove the excess plants when most of the seed had germinated. Commonly the cultivation of corn is restricted to its being hoed once or twice to eliminate the weeds, or the weeds may simply be removed by hand pulling.

In various parts of the country the corn harvest varies from the time the grain reaches the milk stage until it is well dried. In the milk stage it is used as a fresh vegetable but normally is mixed with other vegetables at the time of cooking; fried corn and corn on the cob are not Indonesian foods. When dry it may be pounded into a coarse corn meal but is more commonly mixed with rice or other foods in lieu of being considered as a food in its own right. In some areas the husk is valued as a wrapper for tobacco, as a substitute for cigarette papers, and in other areas the ear shoots are harvested before the grain develops and are used as a vegetable. A gruel or porridge of corn meal and grated coconut is common in some areas, while in others rice and corn meal are common; the percentage of each is dependent upon the relative prices.

Corn harvesting is completely a hand operation, and even if there were not such an abundance of labor available, the low yields would prohibit the use of machinery for economic reasons. After the corn is harvested, the leaves and sometimes the stalks are used for livestock, but the use of corn as a grain feed is entirely accidental and unintentional. When the mature grain is harvested, there are two general storage practices. The first, which is especially common in Sulawesi and the Lesser Sunda Islands, is to tie the ears together at the butt either with strips of the husk or with thin slivers of bamboo and to hang the ears on a bamboo rack (Figure 41) or to tie the string of ears around a tree (Figure 42); the second method is to smoke the ears either with or without prior boiling in water with sugar so as to have a dried corn which still is protected by the husk.

The open storage of corn on racks leaves much to be desired. Inspection of racks on Sulawesi, Bali, Sumba, and Java in 1952 showed between one-third and one-half of the racks to be damaged by weevils, and where there was any weevil damage, it was virtually 100 percent. There were no cases of mild to medium damage; the racks were either free of weevils or were completely infested.

Figure 42. Corn tied around coconut tree for storage on Sumba

Figure 43. Cassava root display at East Java fair

D. Cassava

Cassava (Manihot) or as generally better known in the United States, tapioca, which is a processed form of the cassava starch, is a root crop planted throughout the tropical regions of the world for direct consumption as food or for processing into edible or industrial starch products. The wide distribution of this crop is a tribute to its adaptability to a wide variety of soil types and moisture conditions. As would be expected, the yields from cassava are much higher under favorable moisture conditions and on fertile soils, but it will produce a greater bulk of food under poor conditions than almost any other tropical food plant. In addition to its adaptability to various conditions affecting production, it is useful as a fresh vegetable, as a delicacy somewhat similar to potato chips when sliced thin and fried, or as a starchy flour to be used with rice, in sauces, or in soups when pulverized by pounding or grating. In addition to these uses of the roots, its leaves, which have a high content of protein as well as some vitamins, have been used as green vegetables by the Javanese people for several generations.

In area planted, cassava is the third most important food crop, but in total production it is first when only weight is considered. In 1952 the reported area[1] of rice,

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1. Soetijo, op. cit., p. 343.

corn, and cassava were respectively 16.57 million acres, 8.0 million acres, and 2.58 million acres. The total production in short tons of these crops in 1952 was rice 7.06 million, corn 3.05 million, and cassava 9.05 million.

Prior to World War II the demand for cassava starch made it a crop attractive to estate agriculture, and in 1939 there were 39 estates producing cassava themselves[1] and 130 more that were buying cassava from farmers for processing. The capacity of the processing plants was only about 10 percent of the total estimated production. In 1937-41 the United States alone imported from Java in various tapioca products, the equivalent of 1.4 million tons[2] of fresh cassava roots annually. Cassava is exported as crude manioc (gaplek), as coarse or fine meal (manioc farina), as flakes and siftings, or as refuse (ampas)[3]. Prior to consumption as food the hydrocyanic acid content of some varieties of cassava tubers must be removed by repeated washing to avoid a toxic effect[4].

Land preparation for cassava consists of plowing the soil or turning it with hoes to a depth of three to five inches, after which time it is bedded in rows spaced about three feet apart. Planting may occur at any time of the

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1. J. H. Boeke, The Evolution of the Netherlands Indies Economy, Institute of Pacific Relations, New York, 1946, p. 77.
2. Metcalf, op. cit., p. 46.
3. Boeke, op. cit., p. 77.
4. U. S. War Dept., Medical and Sanitary Data on Java, TBMED, 102, Washington, 1944, p. 13.

year and is accomplished by setting out cuttings of the canes from other fields at two to three foot intervals in the rows. Little cultivation is required as the plants are soon tall enough and covered with ample foliage to effectively shade the soil and prevent any substantial weed growth. At any time after the cassava has been growing for three months or more, the roots may be dug for use as a vegetable, but the normal growing season is eight to ten months. However, most cassava is planted about the end of the rainy monsoon and is harvested near the end of the next wet monsoon.

When dug, the clusters of roots are comparable to a cluster of sweet potatoes except that the roots are very much elongated. Most of the roots are no more than two to three inches in diameter at the thickest point but are often as much as ten to fifteen inches in length (Figure 43). When stored for home consumption the roots, either whole or quartered, are placed in the open until dry and are then stored in a dry place until ready for use. The roots may be processed for food by pounding them with a wooden pestle in the same mortar used for rice and then pick out the coarse fragments of peelings from the dry flour but the roots are often pulverized by grating.

E. Horticultural Crops

The distribution of the population of Indonesia has

retarded the development of horticultural crops as the major agricultural enterprise except in a few relatively small areas. The pattern of population distribution has changed slightly in recent years, but it is estimated that at least 75 percent of the population still live in the rural villages from whence the farmers walk to their fields. Each village, or kampong, is literally a mixed orchard containing several kinds of fruit cared for primarily for home consumption. The fruits most commonly observed are papaya, banana, mango, orange, grapefruit, rambutan (Nephelium lappaceum, L.), and jack-fruit (Attocarpus integra, Thund. Merr.). In addition to these fruits coconut palms and kapok trees are very common. Under the mixed orchard of the farmyard it is quite common to see cassava, taro, or some other plant which may be used as a vegetable. Beans, peanuts, and cassava are grown as secondary crops after rice, or where irrigation is impossible, may become the principle crops. These crops are used as fresh vegetables, but they may be also used in other forms after they are fully mature. The so-called European type vegetables such as cabbage, white potatoes, tomatoes, carrots, and squash are found in areas adjacent to those cities where the soils and climate are favorable. Near every major city there is a small area where the production of vegetables, fruits, and flowers is the primary type of farming. Because most of the cities are in the lowland areas along the coasts, most of the vegetable

producing areas are in the mountains nearby at elevations above one thousand feet where the climate is more favorable; this practice is especially true for potatoes, cabbage, and tomatoes which do not produce well at the lower altitudes.

Current statistical information on the production is not available, and it is doubtful whether the true importance of horticultural crops will ever be known because most of them are produced for home consumption and the amount consumed is largely dependent upon the supply available. The Netherlands Indies Government conducted surveys prior to 1930 which, while outdated, give some idea of the fruit production on Java. Ochse[1] and his colleagues estimated the total area in the kampongs of Java and Madura at 5.2 million acres in 1925; to say that this area is the villages is synonymous with saying that this area is in mixed orchards (Figure 44) as the houses are spaced between the fruit trees but the houses usually are so small that the spacing of the trees is not greatly affected by their presence.

It was estimated according to Ochse, by the Central Bureau of Statistics that in the period of 1925-30 a total of 28,000 short tons of fruit was brought into Djakarta annually by various means of transportation. Because the

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1. J. J. Ochse with R. C. Bakhuizen Van Den Brink, Fruits and Fruit Culture in the Dutch East Indies, G. Kolff and Co., Batavia (Djakarta) Indonesia, 1931, pp. 1-188.

Figure 44. Miscellaneous fruit trees surrounding kampong in Central Java

Figure 45. Fruit market in Djakarta

estimated population of the city today is at least four times as large as before the war, the volume must be far greater. Fruits and vegetables are brought into the city daily on pikulans, on bicycles, in betjaks, in carts, in trucks, and by rail. Most of the produce transported by rail is hauled as the free luggage of the third class passengers who transport their produce from the farm to the railway station and later from the railway station to the market with the pikulans. The same system of marketing fresh fruits and vegetables is visible in all of the cities, a system which makes little if any use of grading and one which makes no use of packaging and wrapping except for the use of very loosely woven containers of thin bamboo strips that are substituted for paper bags. Because all paper is imported, it is so expensive that paper bags and wrapping paper are seldom seen except in the best stores; if wrapping paper is used at all, it usually is old newspaper.

Fruits and vegetables are not ordinarily sold in grocery stores as is common in America; instead they are sold in the pasars (Figure 45) either by the farmers who have brought their produce to the market or by small traders who often are of Chinese ancestry. The marketing process is time consuming, both for the traders and for the purchasers, because the various fruits and vegetables are at different parts of a market or even in different markets and no single trader has a complete selection; therefore, it is necessary

for the purchaser to go to a different trading stall for each item desired. With few exceptions, there are no fixed prices for produce in Indonesia -- the same condition common in other parts of the Middle East and the Far East. The sale of every item is accomplished after a period of bargaining over the final price to be paid; the process usually begins with the "asking price" of the trader followed by an offer from the would-be purchaser that usually is only 25 to 35 percent of the "asking price". After a period of discussion a compromise may be reached; whether it is near the "asking price" or the "offering price" depends primarily upon the individual bargaining abilities of the trader and of the purchaser and secondarily upon the instantaneous situation of supply and demand. If one is purchasing several units of a particular fruit or vegetable, the usual bargaining technique is to obtain the best possible price on a single unit and then to bargain again for the total price to be paid for more than one unit. The relation between the "asking price" and the final selling price is often a good index of the patience of the purchaser; if one has the patience to wait for a long time over the few <u>sen</u> of the price, it is possible to buy at relatively low prices, but if the purchaser is in a hurry, then the price will be relatively high. The importance of bargaining is, perhaps, best illustrated by the fact that foreigners, especially Americans, until they have been in the country for a long time, often pay up to two or three times the price for fruit and vegetables paid by Indonesians.

From the standpoint of the farmer or trader who thus sells the fruit or vegetables, this process of bargaining holds the volume of an individual's sales to a minimum. From the standpoint of the consumer there is a great loss of time in the purchase of even the minimum requirements for daily needs. Because of the absence of refrigeration in the homes of all except the very wealthy, perishables must be purchased in small quantities, a practice accentuating the time required for the purchase of the requirements of even a small household.

The propagation of most of the fruit trees of Indonesia is from seed, although the Horticultural Division of the Farmers' Agricultural Service maintains a number of nurseries where the selected varieties of the best fruits are propagated through cuttings, by grafting, or by budding. Commercial nurseries are of little importance except for ornamental plants in the vicinity of the larger cities. The Horticultural Division is establishing a number of new nurseries so that in the future, planting stocks of the better varieties of fruit will be available to the farmers. Bananas are one of the exceptions to the above statement because the normal propagation of this fruit is by transplanting suckers that emerge from the base of old plants.

Because fruit culture is generally for home consumption and is a secondary farm enterprise, little attention is given to disease and insect control. Rigid spray schedules common in other parts of the world are vitually unknown here, but even so there seems to be little evidence of insect damage in the fruit purchased in the markets. Trees which become diseased are simply removed and replaced by others which are bearing fruit in a short time.

Commercial vegetable production, in the few areas where it is important, seems to have attracted or to have developed a more progressive group of farmers who use compost and nitrogenous fertilizer regularly and who commonly spray or dust their crops for the control of insects and diseases. Production is almost continuous throughout the year, and after a small plot is harvested, it is almost immediately prepared and replanted in another crop. The Agriculture and Fishery leaflet of the Ministry of Information[1] names six locations on Java and one in Sumatra where commercial vegetable production is a major enterprise. In addition to these areas enough vegetables and fruits are produced on Bali to be a regular export item to Java and even to Singapore.

The principle vegetables of importance -- cabbage, Chinese cabbage, lettuce, beets, beans, carrots, spinach, tomatoes, white potatoes, and sweet potatoes -- are usually in good supply in the markets of the cities. Except for

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1. Ministry of Information, Indonesia Today, Agriculture and Fishery, Djakarta, 1951, Leaflet, pp. 1-4.

white potatoes, onions, and tomatoes the size of Indonesia's vegetables compares favorably with those of other parts of the world, but the tomatoes, onions, and white potatoes generally are very small and the tomatoes especially are rather bland. Because of ecological factors the white potatoes produced are not considered satisfactory for seed, and it is necessary to import seed potatoes from Europe.

Sweet potato culture presents a contrast to the familiar American culture. The Indonesian farmer finds the practice of placing potatoes in a bed and removing slips from the bed for transplanting to the fields to be an unnecessary procedure. Many American farmers transplant and later use vine cuttings from fields after sufficient growth has developed, but the Indonesian farmer is able to remove vines from the previous crop to enable further plantings. On Sumbawa where the production of sweet potatoes is being introduced and encouraged by the Agricultural Extension Service, the author observed in November 1952 a truck load of vine cuttings being transported from one village to another about forty miles away.

The Horticultural Division of the Farmers' Agricultural Service, as previously stated, is operating nurseries for fruit trees in the various provinces. Also the numerous demonstration and seed farms of the Agricultural Service are introducing new vegetables, conducting experiments to

improve varieties of vegetables already in local use, and making experimental plantings of tree crops such as cacao, cloves, nutmeg, and coconut in those areas where there is no demand for vegetable and fruits except for farm consumption. Most of the emphasis on commercial vegetable production is concentrated near the major population centers, and the work with horticultural tree crops is more common on the Outer Islands. The limitation that transportation facilities places upon the distance perishable produce can be transported to market dictates the principle interest of many of the demonstration gardens. In Figures 46 and 47 are shown some of the demonstration gardens of the Service concerned with horticultural crops.

F. Peanuts, Soybeans, and Pigeon Peas

Peanuts, soybeans, and pigeon peas are the remaining food crops of importance to the Indonesian farmer; however, lombok or chili pepper is certainly worthy of mention, for and Indonesian meal is incomplete when some of the food is not so highly seasoned that one unaccustomed to it cannot eat without consuming much liquid. Peanuts are commonly eaten as roasted or actually fried nuts, but they are also used in other forms -- the most notable of which is the peanut sauce often served with sate, the tasty bits of meat spitted on small pieces of bamboo and barbecued over charcoal

Figure 46. Horticultural Garden of the Farmers' Agricultural Service on Amboina

Figure 47. Cacao, Papaja, and citrus trees in Horticultural Garden on Sulawesi

pots. The basting sauce for the sate is also generously seasoned with lombok, and the meat is dipped in the sauce and eaten directly from the bamboo spit.

Peanuts are cultivated throughout the Archipelago with almost every farmer planting small patches in the dry monsoon after rice or in unirrigated fields, either alone or interplanted with corn or other crops. They are also often planted in rows between cassava, and because the peanuts mature in three to four months while the cassava requires eight to ten months, this cropping practice permits a greater utilization of the small areas of land that the farmer is able to cultivate with his limited animal power and primitive tools. The most recent estimates of the areas and production of peanuts are shown in Table IV.

Soybeans, along with pigeon peas, are the most common sources of bean sprouts which are so common in the Indonesian diet, either in lieu of or mixed with other vegetables and often served with sate and peanut sauce. Soybeans are sometimes broadcast but more commonly are planted in rows and cultivated because their primary value is for food production, and their value for forage or for soil building is secondary. In contrast to the careful attention given peanuts, soybeans, and other crops there is little attention given to pigeon peas, especially in the Lesser Sunda Islands where they have the greatest importance.

Pigeon peas are often sown broadcast on rice stubble and receive no cultivation. In areas of ladang culture the brush is often burned off at the end of the dry monsoon, the peas are broadcast with no further attempt at soil preparation, and they are covered only by dragging brush over the field, if they are covered at all. No further attention is given the crop until the peas are ready for picking. Under this type of culture officials of the Farmers' Agricultural Service estimated the yield on Sumbawa at 250 to 300 pounds per acre in 1952.

G. Sago

The sago palm (Metroxylon), Figure 48, is indigenous to the swampy areas of Indonesia, but only in the Moluccas and a few other areas of less importance has this tree been of material use to the people except for the use of its fronds as a thatching material. In the Moluccas the sago palm has not only furnished materials of construction but has also produced one of the staple foods of the area, a food which is the insurance of the people against famine because of its availability and at the same time perhaps one of the factors that has retarded the development of agriculture in this island group because the people have always been aware of the fact that if no other food was available they could cut another palm tree.

The normal habitat of this tree is in the swamps, and it seems to make little difference whether the water be

Figure 48. Young sago palm tree in edge of Amboina swamp

Figure 49. Selected cacao seed tree near Ambon

fresh or slightly brackish. The usual culture is simply the wild growth of the trees in the swamps, but they are said to be planted and cultivated in a few small areas of the islands. When cultivated the palms are planted with 18-foot spacings or at the rate of 160 trees per acre. Under this favorable spacing they will produce logs 12 inches in diameter and 20 feet in length in six to seven years, while ten to twelve years are required to attain the same size under the competitive conditions of the swamps.

The pulp of the sago palm is processed to obtain a flour used in cakes, breads, soups, and puddings. While to one accustomed to wheat flour it is not a delicacy, the food prepared from this flour can be very good. One type of bread that is highly regarded by the fishermen and the hunters of the area, as well as by warriors of former times, is prepared by pressing the sago flour into cast-iron molds previously heated until almost red hot so that the biscuits will cook without further heat. The usual size of these biscuits is 1½ x 2 x 3 inches. These biscuits will keep for long periods of time and are eaten after being moistened with either salt or fresh water, or they are often dunked in coffee or tea and are eaten either hot or cold.

The carbohydrate value of sago flour is approximately 65 percent that of rice, but proteins and vitamins are almost completely absent. Because of this fact there is said to be a serious nutritional deficiency in the diet of the people, for the principal source of animal protein available is fish and since the war the supply of fish has been inadequate to fill the needs of the people.

CHAPTER X

PRINCIPAL EXPORT CROPS

A. General Conditions of Commercial Crop Production

In contrast to the development of food crop production which has been the result of necessity, the production of export crops for Indonesia is the result of the extensive efforts of the Netherlands East Indies Company and later the Netherlands Indies Government to produce raw agricultural products for the shipping and industrial interests of the Netherlands and for world markets. While the first crop, sugar cane, was introduced by the Chinese, soon afterwards began the continuing efforts of the Company and the Government to introduce additional crops adapted to the country and suitable for export, efforts which did not stop until the Dutch lost control to the Japanese in 1942.

Many of the crops which were introduced were not well adapted initially and required extensive research before commercial production could be attempted. It was more than thirty years from the time the rubber trees were imported before commercial rubber production became important; a combination of low yielding varieties and world market conditions kept rubber production at a low level prior to World War I. Cinchona, from the bark of which quinine sulphate is extracted, was unsuccessful until high yielding

varieties with their climatic limitations were determined through research extending from 1852[1] until about 1875.

According to statistics from the Netherlands Indies Government prior to the Japanese occupation, the estates operated 7.4 percent of the cultivated lands of Java and Madura[2], but with post-war increases in farmers' agriculture and the loss of lands by the estates, the percentage controlled by the estates has decreased. As has been stated earlier, the people have given more attention to commercial crops since the beginning of the Twentieth Century so that today the bulk of the exports are from the farmers.

While certain crops such as oil palm, sisal, wrapper tobacco, and sugar have been primarily produced by large, well equipped estates with adequate technical personnel, other export crops such as kapok, copra, pepper, and various spices have always remained products of the farmers. There are other crops with characteristics that permit profitable production either on the small, primitive scale of the farmer or on the vast, well organized scale of the estates.

The coconut occupies a special place in Indonesian agriculture because of its importance as a source of cooking oil. Even though the Moslem religion prohibits the use of pork, it is likely that coconut oil has always been the

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1. Vlekke, op. cit., p. 277.
2. Soetijo, op. cit., p. 337.

principal cooking oil because of its availability. In the Outer Provinces, especially in the northern part of Sulawesi, production of coconuts for copra for export trade is of major importance.

Tobacco, pepper, and sugar cane are the only field crops of importance produced by farmers primarily for the market. Most of the tobacco produced for market by farmers is concentrated in East Java and Madura, although tobacco for home use or for the local market may be seen throughout the Archipelago. Most of the commercial production of sugar cane is in East Java, but there is some in Central Java and a small amount in West Central Sumatra. In most other areas sugar for local or home use is from the aren palm. Red pepper is also found throughout the Archipelago but is produced primarily for home use or is consumed by the local market. The commercial production of black and white pepper is concentrated in South Sumatra and on the islands of Bangka and Billiton. Prior to the war this area produced 75 percent of the world supply[1], but many of the gardens were destroyed during the Japanese occupation and production is still far below the pre-war level. Both black and white pepper are from the same plant, the color being dependent upon the time of harvesting the pods.

The principal tree crops, besides fruit tree crops, which receive attention from farmers are kapok in almost

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1. Metcalf, op. cit., pp. 78-79.

all areas, tea on Java and Sumatra, coffee on Bali, Java, and Sumatra, rubber on Sumatra and Kalimantan, and cloves and nutmeg in the Moluccas. Generally, except for the spices in the Moluccas, attention given to the tree crops is of secondary importance to rice, and the amount of these crops harvested is sometimes determined by the relation between the market price of the product and the price and availability of rice on the local markets of the various areas.

B. Cacao

The cultivation of cacao (Theobroma cacao) has never occupied an important position in the export crops of Indonesia, but at the present time the Farmers' Agricultural Service is encouraging the planting of cacao by farmers through the distribution of seedlings from high producing stock. At the various seed farms of the Service nurseries, seeds from high producing trees are planted and the one year old seedlings are sold to farmers at prices below the actual cost of production; however, the nurseries are operated as a part of the training schools for the mantris of the Service, and properly a portion of the cost should be charged to the training of better qualified employees of the Service.

The cacao tree is like the coffee plant, at least for several years, in that it requires moderate shade and the *dadap* and *albizzia* trees are commonly used. In cacao groves the shade trees may be gradually eliminated as the cacao trees attain sufficient size to provide adequate shade for the young stub limbs extending from the trunk and from the older limbs of the tree on which the fruit is borne (Figure 49); however, when kapok is the shade tree it remains. When the cacao plants actually attain the size of trees after ten to fifteen years, they are able to provide their own shade; the shade trees are no longer essential to protect the seed pods from the sun.

C. Cinchona

About 1850 the cinchona tree, from whose bark quinine sulphate is extracted, was introduced in the Netherlands East Indies from South America through the efforts of the Government to introduce plants of commercial importance in world trade, and after many disappointing experiments the selection of varieties producing high yielding barks was possible. The importance of this product is the result of its value as a malaria prophylaxis, which prior to the development of synthetic drugs permitted the Cinchona Producers' Association to control the world market. Prior to the war 90 percent of the world's supply came from Java[1], and even this was concentrated in West Java where there were alkaline soils between the elevations of 4,000 and 6,000 feet

1. Ibid., p. 77.

which permitted production of trees with high yielding barks, 5 to 6 percent quinine sulphate. Because the cinchona tree is so limited in its range of permissable climatic and soil conditions and because the trees must grow for four to six years before any harvest is possible, its culture has remained primarily an estate operation.

The decreasing importance of quinine in the world is indicated in the average export of 12,325 short tons of bark and 187 tons of quinine during the period 1935-39 and by the statement of the Chief of the Government Agricultural Estates in March 1953 that only 10 percent of the 1952 production of 605 tons was exported because of the falling demand. Because quinine sulphate is being displaced by synthetic drugs, the more than 40,000 acres formerly in this crop will probably be replanted in coffee or tea, especially in view of the fact that many of the plantings were secondary operations of estates whose primary objective was the production of tea or other crops.

D. Coffee

The cultivation of coffee in Indonesia was initiated about 1700 under the sponsorship of Nicolas Witsen[1], the burgomaster of Amsterdam and a member of the Board of Directors of the East Indies Company, and was so well

1. Vlekke, op. cit., pp. 179-180.

adapted that after the initial distribution for planting, about 1707, coffee production reached the twelve million pound level in a period of only twelve years. The plant introduced was C. Arabica, which has been generally replaced by C. Robusta because of the greater resistance of the latter to the leaf diseases[1], but according to agricultural officials Arabica is still preferred for planting at elevations above approximately 3,000 feet.

Coffee requires well drained soils of medium to high fertility, seventy inches or more annual rainfall which is evenly distributed, and moderate to dense shade. The shade necessary for coffee is commonly obtained by planting dadap or albizzia, both of which are fast growing trees, and if planted three to four years before the coffee plants are set out, will provide the necessary shade. Coffee begins yielding light crops after three years and reaches its maximum production level after six to seven years. On estates systematic pruning schedules are followed in order that the size of the coffee plant will remain small enough to facilitate harvesting, but in the plantings of the farmers little attention is given to the plant except for picking the beans.

Coffee beans are borne in clusters along the branches of the plant and when mature are handpicked for processing.

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1. Metcalf, op. cit., pp. 70-71.

Prior to marketing, the outer pulp of the coffee bean and the inner lining, similar to that of a peanut, must be removed and the bean dried. As prepared for the market the coffee bean is a light green color with little aroma, the familiar aroma and dark color being the result of the final processing for consumption.

In the period 1934-38 there were 283,525 acres[1] in coffee on 429 estates producing an average of 61,050 tons of coffee from the 258,607 acres old enough to be in production. The average export from Indonesia during this same period was 92,400 tons, of which 42 percent came from the estates and 58 percent from the farmers. In 1948 the export was only 2,200 tons and in 1950 this had increased to 15,400, but only 155 estates had been able to resume production of the damage both to the coffee plants and to processing facilities either through direct damage or through neglect. According to Metcalf[2], 20 percent of the production is being smuggled to Singapore at the present time, a fact that would indicate that production has been reestablished to a greater degree than the above figures indicate.

E. Copra

Because of the consumption of fresh coconuts by the farm people, the sale of fresh coconuts in the local markets,

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1. Soetijo, op. cit., p. 359.
2. Metcalf, op. cit., p. 71.

and the individual processing of coconut meat for cooking oil, the real value of this crop to the agricultural economy of Indonesia can never be accurately estimated. Even the importance of the crop for export as copra cannot be determined because of the free trading or smuggling that takes place between East Sumatra and West Kalimantan with Singapore and between North Sulawesi and the Philippines. In addition to the coconut's value for its meat or its oil, the number of coconuts used for coconut milk as a beverage might well be of sufficient magnitude to affect the overall picture. In contrast to the coconut milk well known to Americans from their imported coconuts, milk which is slightly tart and tends to have a laxative effect, the coconut milk or the coconut water, as it is known in Indonesia, is a refreshing beverage that is always cool and perfectly safe to drink, in contrast to water which generally is unsafe to drink unless boiled or chemically purified. Indonesians make coconut milk by pouring water on grated coconut and letting it stand for a short-time before squeezing. The pressed coconut meat is discarded and the coconut milk is used as a substitute for cow's milk in cooking.

Coconut production, either for copra or for local consumption, is primarily a product of the farmers who, after supplying their own requirements for fresh coconut meat to mix with vegetables and meats for cooking and for home processing for cooking oils, husk and dry the remaining coconuts for sale to the Copra Foundation. In addition to being the sole exporting agent, the Foundation also purchases copra for resale to the domestic oil mills in the amount of slightly more than 119,000 short tons annually for the production of margarine and soap.

The estimates of production of coconut palms vary from 25 to 100 nuts per year, the lowest being from the poorly cared for trees of some farmers and the highest being from the few estates where good management and fertilization practices are followed. The normal harvesting method is for a laborer to climb the trees, using notches cut in the trunk as steps and carrying with him a machete, with which he cuts out the nuts that are mature. The farmers follow no regular schedule, but the estates harvest the nuts at regular intervals. A variation from the normal harvesting procedure is used to a limited degree in West Central Sumatra where medium sized monkeys are trained to climb the trees and pitch the mature coconuts to the ground (Figure 50). While it is said that the owner can indicate by signals which nuts are to be picked, it seems likely that the mature nuts are easier for the monkey to pluck from the cluster. The trainer controls the monkey by voice and hand signals and by the rope leash. Under this system the trainer or owner of the monkey receives a share of the coconuts for services rendered. On Java the demand for fresh coconuts is so great that the production of copra is negligible; however, in the other areas where there is adequate,

Figure 50. Monkey trained to harvest coconuts, West Central Sumatra

Figure 51. Coconut nursery in Central Sumatra

evenly distributed rainfall copra is of more importance except, at altitudes greater than 3000 feet where the coconut palm is not adapted.

Coconuts are propagated by seed; the unhusked nuts are hung in the shade and allowed to sprout; then the nuts are half buried in nurseries until ready to transplant into holes approximately three feet square and three feet deep which are half filled with compost and topsoil prior to transplanting; additional soil is worked into the hole as the palm grows. The Farmers Agricultural Service is encouraging farmers to select seed nuts from high producing trees and by way of demonstration of good nursery practices has small nurseries (Figure 51) as a part of the demonstration seed farms at several locations.

The export of copra increased from 321,655 short tons in 1950 to a total of 577,531 short tons in 1951[1], an increase which placed the export approximately 11,000 tons higher than the 1935-1939 average[2]. The recovery of this export trade reflects to a considerable degree the influence of the farmers' ability to carry on normal production as the farmers produce 95 percent of the copra in contrast to some of the other crops which are predominately estate crops. The recovery of the export trade is also indicative of the negligible amount of equipment necessary for copra

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1. Kantor Pusat Statistik, Ichtisar Bulanan Statistik (Monthly Survey), Djakarta, July 1952, p. 16.
2. Metcalf, op. cit., p. 66.

processing because other export products have been hampered both by the deteriorated condition of pre-war equipment and the difficulty of replacement.

F. Fiber Crops

Sisal (Agave sisalina) is the principle hard fiber produced in Indonesia. Just prior to the war approximately one-third of the world's production of this crop was concentrated on Java and Sumatra[1]. Other fiber crops planted in the Archipelago include abaca (Musa textilis), cantala (Agave cantala), roselle (Hibiscus sabdariffa), kenaf (Hibiscus cannabinus), and ramie (Boehmeria nivea). Fiber production has typically been an estate enterprise, and almost the entire production has always been exported as raw fiber in the absence of textile and cordage mills. A small amount of cotton has been produced by the people of the Eastern Islands, but cotton has never been of appreciable importance. In East Java and in the Lesser Sunda Islands there is a small amount of cotton but it is ginned, spun, and hand-woven by the producers.

Sisal and abaca are normally propagated by transplanting the suckers which emerge from the base of the mature plants. These suckers emerge after the plant is three years or more in age, and transplanting to nurseries or directly to the

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1. Ibid., p. 73.

fields may be observed in the vicinity of Medan, where the Sumatra fiber production is concentrated. The procedure followed is primarily controlled by the time of the year the suckers emerge and whether the fields for final plantings are ready for transplanting. The long sword-like leaves from planting stock which has been in nurseries for a year or more may be harvested earlier than those from suckers directly planted in the fields, but the cost of the extra labor offsets the advantage of the earlier harvest after transplanting to such a degree that estate managers believe that there is little economic difference. Roselle and ramie are propagated by transplanting rhyzomes from established plantings; after planting, the stand of both increases from the root systems, and both must be grown in a stand of sufficient thickness to cause erect growth with few limbs. If there are many limbs on the plants, the length and quality of the fibers are much lower than with erect, sparsely limbed plants.

In all of the fiber plants the weight of marketable fiber is only 2 to 6 percent of the weight of the material harvested. The fiber must be separated from the bark and gummy binder or leaf pulp by decortication. The farmer accomplishes the decortication by placing the material in water and permitting it to rot until the waste material can be hand-scraped from the fiber and the fibers combed. On the estates the decortication processes are accomplished partially by hand and partially with machinery.

In 1952 the Ministry of Agriculture, in cooperation with the Small Industry Division of the Ministry of Economic Affairs, began a program of experimental expansion in planting ramie. Under this program the Farmers' Agricultural Service will be responsible for the establishment of experimental plantings of ramie in all parts of the Archipelago where the soil and climatic factors are favorable. The Small Industry Division will be responsible for obtaining the minimum amounts of machinery and establishing facilities for decortication of the fiber produced and in addition will be responsible for arranging the sale or barter of the partially processed fiber. It is important that this or other fibers adapted for use in textiles and in cordage be developed to meet the domestic needs of Indonesia. Because ramie is suitable for both textiles and cordage and apparently is also well adapted to the climate and soils of some parts of the islands, it was selected for the concentrated effort to increase fiber production. One of the greatest cordage needs of Indonesia at this time is for fishing nets and other fishing accessories in both the inland and the sea fisheries industries. Ramie fiber is especially well adapted for these uses because it has a high tensile strength and is unaffected by repeated wetting and drying common to fishing equipment.

G. Kapok

The kapok tree (Ceiba pentandra) is well adapted to the casual attention received by any plant or crop in Indonesia except rice or other food crops. Its tapered trunk and sparse limbs, perpendicular to the trunk, are characteristic of the Javanese landscape and to a lesser degree that of the other islands. The seed pods of this tree yield a silky, cotton-like, short staple fiber which has long been valued for its buoyancy and its properties of insulation, either for heat or sound. It is said that this fiber will support thirty times its own weight[1], and for this reason it has been commonly used as the packing material for life-preservers. Domestic use of the fiber is for padding in the better furniture and also for mattresses. In addition to the fiber the pods yield seeds, from which approximately 24 percent edible oil may be extracted.

The tree has an odd appearance (Figure 52), in that its tapered trunk may reach a height of fifty feet or more; the branches are sparsely spaced along the trunk and extend as almost true perpendiculars to the trunk and give the tree something of a scare-crow appearance, especially in the dry monsoon when there are virtually no leaves on the tree. The trees are normally scattered through the kampongs at irregular intervals, and only in exceptional cases are

1. Ibid., p. 76.

Figure 52. Kapok trees along river bank in Djakarta

Figure 53. Grove of oil palm trees in Northeast Sumatra

there any kapok groves. Prior to the war, according to Metcalf, there were only about 40,000 acres in estate plantings where the spacing was ten trees per acre, although the export indicated that solid plantings of nearly one-half million acres would have been required to obtain the estimated production.

Similarly, the Almanak Pertanian[1] shows the area in production in 1950 to be only 16,300 acres with a total yield of only 1196 short tons of fiber and 2081 tons of seed, while the export was reported at 8800 tons of fiber only. Only 17 percent of the export was attributed to estates, with the bulk of production coming from the unreported, scattered plantings of the farmers, for which accurate area estimates cannot be made.

The sparseness of the limbs of the trees is indicated by the experience of the Catholic Mission on Flores where the attempt to use kapok to provide the shade necessary for C. Robusta has proven unsatisfactory. On the Mission's Hokeng estate albizzia is being interplanted under the kapok; the coffee is being severely pruned; when the albizzia attains sufficient size, the kapok will be cut except for enough to provide the Mission's need for its own use. This attempt by the Mission to utilize kapok trees for shade for coffee is a marked departure from the general rule of the kapok trees being scattered through the kampongs.

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1. Soetijo, op. cit., p. 366.

Kapok trees are often found on the terraces between the rice fields where their lack of shade probably eliminates any visible effect on the adjacent crops. While it is probable that there is competition for plant nutrients between the trees and the adjacent crops, in the presence of ample water supplies for irrigated fields the results of such competition is not apparent.

Harvesting consists simply of shaking the tree so that the pods fall off, or they may be knocked to the ground with a bamboo pole; in either case the pods must be harvested before they open on the trees or the fiber will be scattered by the wind. Processing consists of removing the fiber from the seed by hand or with simple ginning devices and drying the fiber in the sun. The value of this crop in the world market of the future is jeopardized by the increased use of glass wool and other synthetic fibers that may necessitate its replacement by fruits and other crops in order to supply the increasing domestic demand for these products.

In addition to the value of the kapok fiber, the seed of the kapok is valued as another souce of vegetable oil, and since the seed accounts for approximately 30 percent of the total yield, this is a factor of considerable importance. The seed, when processed, yield about 25 percent of their weight as oil, or of the total production of the kapok tree 50 percent is fiber, 12.5 percent is oil, and 37.5 percent is seed cake, cake that should have a high protein content and a

source of high protein concentrate for livestock.

H. Palm Oil

The oil palm was brought to Indonesia from Africa[1] in 1848, but the first oil palm plantations were not established until 1914. From 1914 until 1939 the oil palm industry expanded so rapidly that Indonesian production of 308,900 short tons of oil and oil palm kernels[2] placed it second in production only to Africa with 24 percent of the total world production and 40 percent of the total production entering world trade[3]. It was estimated that the pre-war area in oil palm was 260,000 acres with 183,000 in production, but the latter had decreased in 1948 to 85,499. In 1950 the industry had reestablished production on 148,260 acres, and the export was only 50 percent of the pre-war figure according to Metcalf, but from the figures of Soetijo[4] approximately 185,000 acres were in production in 1950.

The palm tree bears eight to twelve clusters of nuts annually (Figures 53 and 54); the oil is obtained from the pulp surrounding the nut; the kernels are obtained by cracking the nuts. The palm kernel yields a different type of oil, also valuable, but few of the kernels are processed in Indonesia. The palm oil is used primarily for the production of

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1. Vlekke, op. cit., p. 276.
2. Min. Inf.; Indonesia Today, Exports. Djakarta, 1951, Leaflet, pp. 1-4.
3. Metcalf, op. cit., p. 68.
4. Soetijo, op. cit., p. 365.

Figure 54. Clusters of oil palm nuts

Figure 55. Sugar cane tied together to prevent wind damage in wet monsoon

soaps and margarines, and approximately 10 percent of the 1950 production was used domestically.

Most of the oil palm plantings have been made on new land cleared either from secondary forest or from alang-alang grass. Deep plowing and harrowing are considered necessary, and other crops are often interplanted until the sixty trees per acre have attained sufficient size to completely shade the ground. The seedlings are started in nurseries and are transplanted with no allowance for thinning.

The clusters of nuts require five to seven months to mature after the fruit is formed, but oil palm production is similar to the coconut palm production in that the trees bloom and bear throughout the year. The clusters of nuts are cut from the trees with machetes and are transported to the mills by ox-cart, truck, and narrow-gauge railways.

Because of the lapse of time from the establishment of oil palm groves until the trees reach maturity and because of the equipment and technical skills necessary for processing of the product, oil palms have remained completely in the hands of estates. This condition was undoubtedly affected to some degree by the location of many of the estates in sparsely settled areas where the indigenous population concerned with agriculture was so small that it possessed little capability of undertaking additional crops, crops which would have of necessity been sold to the estates for processing as is the case with tea.

I. Rubber

The rubber industry in Indonesia is a Twentieth Century development. Hevea Brasiliensis was planted in the Botanical Gardens at Bogor in 1883[1], but in 1914 the production had reached only 8250 short tons. However, between 1883 and 1914 the Netherlands East Indies Government and the associations of privately owned estates had conducted sufficient basic research in rubber culture to enable the rapid expansion under the existing favorable world market conditions. The characteristics of the tree itself were very favorable to its widespread planting. Rubber trees grow well over a wide range of soil conditions provided there is adequate, evenly distributed rainfall. The principle soil requirement is that of good drainage, a requirement which normally prevents any competition between this crop and rice because rubber generally is planted on sloping terrain where irrigation is not practical. The fertility level of the soil makes little difference in the productivity of the rubber tree. Only on a few low-lying, heavy clay soils of South Sumatra has there been any measurable response to the use of nitrogenous fertilizers, and a few areas on Java have proven phosphate fertilizers to be beneficial.

The rubber plantations maintained by the estates look like well kept parks; no underbrush is visible, although

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1. Vlekke, op. cit., p. 294.

some estates maintain green manure crops under the rubber trees, while others follow a clean cultivation routine that does not even leave visible weed growth. There are two definite schools of thought on the clean cultivation versus green manure crop practices, with the exponents of the former claiming that the clean cultivation reduces the fire hazard and eliminates competition of the trees with other plants for soil moisture and plant nutrients. The group which favors the green manure crop under the trees claims that the loss of rainfall by runoff is decreased, that erosion is decreased, and that the green manure crops maintain the fertility of the soil and enable sustained production at a higher level. Neither claim is adequately substantiated by experimental data. On some of the plantations under either type of culture, catch-basins are used to prevent erosion on sloping lands and to increase percolation of rainfall into the soil.

On the estates rigid tapping schedules are followed after trees are brought into production six to nine years after planting; the tappers make a new cut on the tapping face every other day. The cut is made with a special knife with a U-shaped tip on the blade which enables the tapper to remove a strip of bark only about a sixteenth of an inch thick. The tapping face is started as high on the tree as the tapper can reach, and he makes a diagonal cut about half the circumference of the tree. At the bottom of the cut he places a small cup to catch the half-pint of latex usually obtained. Aluminum cups are preferred but others are used, and many of the farmers even use half-coconut shells. The tapping is done only in the early morning hours as experience has shown the yield of latex to be higher at this time, and the collection begins about the middle of the morning. As the cups are collected, the latex is poured into larger containers, and the cups are rinsed in a bucket of water carried by the collector. One tapper is able to tap three to four hundred trees during the above hours or is able to cover an area of two to five acres, depending upon the spacing of the trees and the topography. Spacings of approximately twenty feet were formerly used on the estates, but at the present time the trend is towards fifteen foot spacings.

When one considers the labor that is required for the cultivation, tapping, collecting, transportation to the processing plant, and operation of the plant, it is apparent that much labor is required. The field manager of a West Java estate estimated that a total of 1250 to 1500 laborers was required on the estate which has 5000 acres in production and another 1500 acres in its concession area being cleared of second-growth forest for planting. The average daily production of this estate in the fall of 1952 was 5.0 short tons.

Initially the rubber industry was developed only by the estates, but this condition changed as the farmers observed the success of the estates and obtained not only the technical knowledge necessary for rubber production but also planting stock from the high yielding trees propagated from seed or clones. In 1938 the farmers produced 47 percent of the rubber; in 1948 their share of the total production had increased to 64 percent, and in 1950 to 76 percent[1].

The expansion of the planted areas of the farmers has been continuous over the past three decades, but the above production data do not present the complete story. The farmers' primary interest is food production until the price of rubber becomes high enough, in relation to rice, that the income from rubber and the availability of food in the local markets make food production unnecessary. Late in 1950 the price of rubber rose to nearly one dollar per pound so that many farmers neglected other crops and harvested latex. In 1951 when the price of rubber declined simultaneously with a rise in the price of rice, the production of rubber ceased its rapid climb when the farmers gave more attention to food production, an indication that a balance had been reached for the most profitable employment of labor. A portion of the rubber exported as farmers' rubber should properly be classified as estate rubber because undetermined amounts of estate rubber have either been stolen from the estates which have resumed operations

1. Ministry of Information, Exports, op. cit.

or have been harvested by farmers who have illegally taken possession of former estate plantings.

Illegal occupation of estate lands and the theft of crops by the indigenous population have been a serious problem confronting estates since the war, especially estates producing sugar and rubber because these crops can be processed along with the farmers' own production and detection is very difficult. Some rubber estates in Central and West Java have been unable to resume operations, or if so, on a reduced scale because of poor security conditions, and some production of these estates has been harvested and sold as farmers' production. The illegal occupation of concessions by the people also poses a serious problem for the Government because the people desire some of the estate lands for their own use and thereby resentment towards the Government is created if the people are evicted. The estate production efficiency is lowered if they are permitted to remain.

Some rubber has always been smuggled out of Indonesia, especially from the east coast of Sumatra to Singapore. A comparison of the export figures released by the Indonesian Ministry of Information[1] and those reported by Metcalf[2], (Based upon reports of the Secretariat of the International Rubber Study Group, London) shows that the legal exports in

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1. Ibid.
2. Metcalf, op. cit., p. 55.

1938 were 95 percent of the total; in 1948, only 65 percent; in 1949, 95 percent; and in 1950, 92 percent. The high percentage of smuggling in 1948 is easy to explain. Some of the leaders of the Indonesian struggle for independence were in the rubber producing areas of South Sumatra; because of the difficulties of communication it was simpler for these leaders to arrange for rubber to be smuggled to Singapore for the hard currency necessary to finance their struggle than to obtain the necessary money in any other manner since the Dutch bridgeheads and Dutch naval vessels controlled the shipping from the major ports.

J. Sugar Cane

The production of sugar cane for processing into sugar was introduced by the Chinese in the vicinity of Djakarta early in the Seventeenth Century[1]. Because of favorable factors of climate and soils and the agrarian policy of the Netherlands East Indies Government, the sugar industry finally became concentrated in the provinces of East and Central Java where there were about 125 modern sugar mills with an annual capacity of about two million tons of raw sugar, all of which was not used because of voluntary limitation effected through the sugar producers' organization at the time of the Japanese invasion in 1942. During the Japanese occupation some of the mills were converted to industrial alcohol production; others were wholly

1. Vlekke, op. cit., p. 145.

or partially dismantled and shipped to Japan; the remainder were operated at only partial capacity because some land was planted to food crops in lieu of sugar cane.

Under the scorched earth policy of the Indonesian people in opposing the Dutch "police actions" approximately 60 of these mills were destroyed and only 45 mills are now in operation. Some of the reamining mills could be rehabilitated and placed in operation, but as most of them are owned by foreign capital, rehabilitation is proceeding very slowly because of the lack of definite Government policy as to the conditions under which foreign capital may be invested in the new Republic, the dearth of capital of many of the corporations, the lack of general security in some areas, particularly Central Java, and the difficulties of obtaining sufficient labor for the field operations of sugar cane production in some areas. The mills that operated in 1951-52 have been faced with thefts of cane from the fields, destruction of cane in the fields by fire, and labor strikes. A few mills in East Java have been able to operate with a net profit, but most of the mills, according to the newspapers, have operated with deficits.

The general basis of operations of the sugar mills and the estates has been as follows. The corporation owns land outright from grants of the Netherlands East Indies Government prior to the enactment of the Agrarian Law of 1870, or they were the holders of long term concessions under terms of the

law. The land owned or leased by the corporations with few exceptions was 2500 acres or less and often no more than 125 to 250 acres -- enough land to permit the establishment of the mill with its accompanying repair shops, power plants, and living quarters for the supervisory personnel. Most land actually used for sugar cane production was and is rented from the individual farmers of the villages, as dictated by the local customs of land tenure and ownership, under terms of contracts approved by the Government.

The rental contracts are approved by the Government provided the rent is according to regulations and provided the frequency of renting the land will permit the farmer to plant a food crop at least once in three years. The minimum rent permitted by the Government in East Java in 1952 was $52.60 per acre. Under this system a farmer may rent land to the estate and then work as a laborer for the estate in the production of cane on his own land; it is a common practice for the rent to be paid in advance in a lump sum at the time the rental agreement is concluded, but the money is not budgeted by the farmer to take care of his needs during the period for which the land is rented.

Sugar cane culture as practiced in Central and East Java under estate management requires vast amounts of labor, but no exact data are available. The canes are normally planted over a three months' period, extending from about the last month of the dry monsoon through the first two

months of the rainy monsoon. Land preparation begins early in the dry monsoon and is accomplished entirely by hand. The soil is worked with spades and broad hoes in such a way that trenches about ten inches wide and twenty inches deep are spaced at three and one-half to five foot intervals with wider and deeper trenches, as required for drainage or irrigation, every thirty to fifty feet and are connected by laterals at about the same spacing. The plant or seed cane is planted in the bottom of the trenches and is barely covered; as the new growth emerges, soil is worked to the plants with each of the three to five cultivations so that when cane is about a year old it is growing on top of beds about twelve to fifteen inches in height. The cane is planted at approximately the beginning of one wet monsoon, grows through the following dry and wet monsoons, and is then harvested after a growing season of fourteen to sixteen months. The estates are generally considered to have the use of the land for eighteen months for each crop.

During the dry monsoon, which occurs in the middle of the growing season, the sugar cane is irrigated as needed, either from diversion systems or with pumps, normally the former. In the course of the cultivation ammonium phosphate or ammonium sulfate is applied as side dressing two to three times with the total application approximating 180 pounds per acre.

A practice gaining in popularity is that of stripping the dead leaves from the bottom of the stalks and tying two rows of cane together (Figure 55) to prevent wind damage to the cane fields. This practice is being used during the second wet monsoon when the cane has attained a height of ten feet or more and is subject to severe lodging even from relatively light winds because the soil is very often saturated at this time. Most of the dead leaves are dropped to the ground between the rows of cane, but some are used by the people as thatching material, although it is very short lived. It seems to be most commonly used for temporary shelters often constructed for wedding parties and other feasting occasions.

Prior to harvest time the estates lay temporary narrow gauge railroads from their permanent mainlines to the fields to be harvested. Because the land is returned to the farmers for at least one food crop after each crop of cane, it is more economical to return the spur tracks to the mill yard after each harvest and the relay the spurs when needed than to have permanent tracks to all of the fields rented over a period of years. The main lines are permanent. The cane is harvested by hand with the laborers using the Indonesian version of a machete to cut the cane just below ground level. At the same time the cane is topped and stripped so that only the bare stalk goes to the mill. The cane is carried on the shoulders of the laborers to the small railway carts on the nearest temporary spur or sometimes on the permanent tracks. Often the small carts on the temporary spurs are pulled to the permanent tracks by bullocks because the temporary spurs are on such grades that the small locomotives cannot negotiate the grades or are on such soft soil that the locomotives, in spite of their small size, cannot move on the spurs. Since the war some mills have not been able to replace or repair their locomotives and are using animals to pull the rail carts to the mills.

The average yield obtained by the intensive attention to the crop as described above is about 80 short tons per acre or approximately three times the average yield obtained in the Louisiana sugar cane area. The sucrose content of the cane is reported as averaging 13 percent, which is slightly higher than the Louisiana average. The direct comparison with Louisiana production is not a true comparison in that Louisiana cane has only a ten months' growing season and usually three crops are produced from a single planting, whereas in Central and East Java the growing season is fifteen months and each crop is the product of a new planting. Detailed studies supported by statistical data not available for Central and East Java at this time would be necessary to reduce such a comparison to a common denominator of cost per pound of raw sugar which in the final analysis is the only comparable factor of the divergent systems.

An important factor in the Javanese sugar industry has been the research work conducted by the Proefstation Oost Java (East Java Experiment Station) established at Pasuruan on the northeast coast of Java by the Netherlands East Indies Government and supported jointly by the government and the sugar industry. It was from this station that the POJ varieties were imported to the United States in the 1920's, when the spread of the mosaic disease threatened the destruction of the cane sugar industry in the United States. The research conducted by this station has led to the high levels of productivity of Javanese cane and its important position in the world sugar market prior to World War II.

In contrast to the highly developed sugar industry of the estates with production for export its primary objective, there has been the sugar industry of the farmers with production for domestic consumption by the low income mass of the population. The production of export sugar has been entirely from sugar cane as is true with the bulk of the sugar for domestic consumption; however, from the standpoint of many individuals and from the standpoint of distribution throughout the Archipelago, the production of palm sugar is more widespread. In contrast to the export sugar industry, the farmers' sugar industry has developed with far less productivity and efficiency but in such a manner that according to Indonesian averages a class of relatively wealthy Indonesian people has resulted.

The principle development of the farmers' sugar industry has been in East Java, where a large number of farmers have planted their land in sugar cane in preference to renting the land to the estates. While the culture follows the same general pattern of the estates' culture, the use of fertilizer is uncommon and the farmers have not been able to develop their own irrigation systems. It is also probable that the land is not as well prepared and the cultivation not so carefully performed as on the fields of the estates where the supervision is by the scientifically trained personnel who have adequate appreciation of careful cultivation and are interested in obtaining maximum yields because the estates usually give a bonus from the profits earned. As a result of these factors the yields obtained by the farmers are only half of those on the estates and range between 38 and 55 short tons per acre.

In the vicinity of Lawang, a village 15 miles west of Bukit Tinggi in West Central Sumatra, the culture of sugar cane presents a sharp contrast to that seen anywhere else in Indonesia. This area is situated at an elevation of about 6300 feet and is only 25 miles from the Indian Ocean. The area is mountainous with insufficient areas which can be irrigated by diversion to fulfill the needs of the people for food production and for land to work. Primitive irrigation systems have diverted the available water supply as high up the slopes as possible for the irrigation of rice, and the slopes above the rice fields are planted in sugar cane. It is estimated that many of the slopes are 100 percent (45^{o}) and a few are even steeper than this.

The chocolate colored, porous topsoil is about two feet in depth and overlies a slightly basic liparitic tuff[1]. While the topsoil is resistant to erosion, the tuff is not and is the material which permitted the formation of the Karbauwengat Canyon near Bukit Tinggi, one of the scenic attractions of the area. The soil is of volcanic origin, is or relatively high fertility, and has a good structure. The rainfall of this area is approximately 175 inches per year (Station 9; Table III), and there are no distinct wet or dry seasons so that there is adequate moisture throughout the year for sugar cane.

The sugar cane of this area is planted in permanent plantings on the steep slopes above the rice fields. One farmer stated that his field had been producing cane since before the war; another stated that his father had planted the cane many years ago; however, local officials stated that replantings usually occurred at intervals of ten to twenty years. The cane is grown in 15 to 18 inch rows without interval between the stalks and is harvested by cutting thirty to forty stalks, enough for a pan of juice, two or three times per week. In a cluster of cane stalks,

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1. Mohr, op. cit., p. 418.

all are cut except one which is left to maintain a live root until new shoots have put out and then the "seed" stalk is also removed. The thirty to forty stalks are carried by the farmer to one of the estimated 250 wooden rollered mills in the vicinity for crushing and to make sugar the juice is evaporated in a circular iron pan over a stone and mud furnace. Local officials estimated that there were about four thousand families producing sugar cane by the above methods in this area with a total area of 5000 acres in cane with annual production of approximately 2000 tons. The cane is transported to the four local markets of the area in small baskets on the women's heads, on the shoulder poles of the men, and occasionally in animal drawn carts. In the markets most of the sugar is purchased by Chinese traders who haul it by truck to Bukit Tinggi and to Padang for resale. The Chinese traders bring to the area the estimated six tons of rice required monthly above local production, as well as textiles and other essential commodities.

K. Tea Culture

In an estensive treatise on the history of tea culture throughout the world, Ukers[1] states that tea plants were

1. William H. Ukers, All About Tea, Volume I, The Tea and Coffee Trade Journal Co., New York, 1935, pp. 109-132, cont'd., 341-373.

growing as ornamental plants in the gardens of Cleyer, a German doctor and naturalist, and also in the gardens of Camphuljs, the Governor General, about 1694. It was not until Von Siebold obtained seed and plant material from Japan about 1824 and Jacobson obtained seed, processing materials, and skilled laborers from China in 1832[1], that the commercial possibilities of tea on the islands of Java and Sumatra began to develop. Earlier experimental work on Bogor had produced indifferent results except for a few samples of high quality tea. Prior to 1860 tea culture was an enterprise of the government only; however, after this time private planters entered the business, and with the import of Assam tea from India and with the introduction of new processing techniques and equipment tea culture flourished.

The establishment of tea processing plants required large investments and also technically trained personnel for the operation and therefore remained in the hands of the estate type of agriculture in the early years. The principle expansion remained on Java until after 1900, when experimental plantings on Sumatra in the vicinity of both Medan and Palembang proved successful. As the estates led the way and demonstrated the methods of tea production, native farmers in adjacent areas began to establish their own gardens adjacent to the gardens of the estates as the

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1. Vlekke, op. cit., p. 275.

factories of the estates furnished a ready market for the production of the farmers. According to Ukers[1] the expansion of tea plantings continued, and in 1927, 210,000 acres on 269 estates on Java, 31,000 acres on 26 estates on Sumatra, and 63,000 acres of farmers' gardens were planted in tea with a total production of more than 50,000 tons annually. In 1950, Almanak Pertanian[2] showed 200,000 acres to be planted in tea with 165,000 in production, 64 percent of which was on estates. In 1951, the export of this product had reached 49,871 short tons[3].

Tea is a shrub or tree of the Theaceae family and in the tropical climate of Indonesia is found only above elevations of approximately one thousand feet. Perhaps the most restrictive characteristic of the Assam tea commonly grown in Indonesia is its requirement for a cool, humid atmosphere with evenly distributed rainfall. The use of shade trees is common in gardens between the elevations of one and four thousand feet, but above four thousand feet shade trees are unnecessary. Successful tea gardens are found on soils ranging from sandy loams to clay loams, but a high humus content is necessary. Leguminous plants for ground cover and erosion resisting hedges have been used for many years, and it has been proven experimentally that increased yields are obtained through this culture.

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1. Ukers, op. cit., p. 126.
2. Soetijo, op. cit., p. 339.
3. Kantor Pusat Statistik, op. cit., p. 16.

Tea is usually started in nurseries from seed and transplanted to the fields at the age of one and one-half to two years. Some gardens have been started, however, by direct seeding in the fields. Because tea is always planted in the mountainous areas, it is found only on relatively steep slopes, and the control of erosion has been recognized as one of the major problems in sustained high levels of production. In addition to the leguminous plants used for ground cover and soil improvement, as well as for erosion control, small basins between alternate rows are also used. These basins which are approximately on the contour are usually from six to eight inches in width, about fifteen inches deep, and about ten feet in length and increase the retentive capacity of the fields so that runoff is minimized while percolation is increased. These basins have proven satisfactory on the more porous soils but tend to result in insufficient aeration on the heavier soils, especially where there is an impermeable strata near the surface.

The tea plants are usually planted in five foot rows with three to four foot spacing in the rows. In order to prevent wind damage, it is often necessary to plant windbreaks along the roads, as well as shade trees within the gardens. The trees and plants most commonly used for ground cover, hedges, and shade or windbreak are, in respective order, _Indigo endacephylla_, _Laucaena glauca_, and _Erythrina lithosperma_.

Tea production from land preparation to the processing plant is almost entirely a hand operation, and even in the plant, suitable machinery for the grading or sorting is not yet available, although the processing as a whole is a mechanized, scientifically controlled operation. The harvesting or plucking, as it is termed, is usually a hand operation with the laborers going over the gardens every eight to fourteen days throughout the year. The shrubs are lightly pruned periodically at intervals of one to three years as necessary, depending upon local conditions of soils, climate, age of the shrubs, and to a smaller extent to the personal preference of the owner or manager; heavier prunings are made at less frequent intervals. The objectives of pruning are to maintain plants within reasonable size limits, to facilitate plucking, and also to make available a sufficient number of young shoots to maintain a high level of production. Because growth is continuous throughout the year, plucking and pruning are continuous on the large plantings of the estates but are not as regular on the smaller areas of the people. Schedules are arranged for both to provide a uniform labor force with full employment. The plucking is normally accomplished by the women and children, while the pruning, because it is heavier work, is done by the mean.

In plucking, the laborer ordinarily pinches out the bud and from one to three leaves but sometimes takes out a rather long stem so that each plucking is a very light pruning. Various types of knives have been developed to permit the coarser stems and leaves to be cut and separated from the buds and the smaller leaves which are of higher quality. The Sperata knife was developed on the Sperata estate near Bandung, West Java and is described by Uker[1] as a sharp V-shaped cutter into which the stems are pressed with the larger stems falling into a carrying sack and the smaller parts being placed in the slendang or shawl in the usual manner. This knife is said to have been enthusiastically accepted by the planters in a time of high prices when the plucking was heavy, but it is no longer used to any great extent except in the high gardens where finer leaves are found.

If the distance is not too great, the harvest is usually carried to the tea factory by the plucker, using either the slendang or the light baskets found in some areas. If the gardens are too far from the factories, then the pluckers carry the leaves to the nearest road where they can be collected and transported by horse or cattle-drawn carts. There is virtually no hauling in the gardens because of the prohibitive slopes. Prior to the war it is said that some cableways were operated, but because of cannibalization of parts and lack of maintenance or replacements these are almost non-existent today.

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1. Ukers, op. cit., p. 360.

L. Teak

Teak (Tectona grandis) is a native tree of Indonesia, and teakwood is commonly considered the best lumber available for construction. It is often used as the framing material for buildings and is also used in all types of furniture, but it is most highly valued as a ship building material. While technically classified as a hardwood because it is a deciduous tree, teakwood is easy to work and actually is so soft that nails have little holding power. Because of the natural oils of teakwood it is not susceptible to damage from termites or from marine borers, and these characteristics account for its value as a construction material.

In appearance the teak tree is somewhat similar to the cottonwood tree; its leaves are almost round and range from six to sixteen inches in diameter. If the tree grows where there is plenty of room, it is inclined to be limby; however, where it grows in a thick stand, the lower limbs prune themselves very quickly so that long straight poles or longs are obtained.

There are two types of teak culture in Indonesia; in both the seedlings are produced in nurseries where they grow in very thick stands for two to four years prior to transplanting. In the Government owned forests where the objective is lumber production, the trees are planted with about ten by ten foot spacing, and between the rows lamtoro, a leguminous shrub, is usually planted for erosion control. Under the normal conditions of high temperatures and rainfall no appreciable mulch cover develops under the teak trees; on the contrary the leaves fall at the beginning of the dry monsoon and are so large that they do not lie closely and constitute a major fire hazard. The leaf-fall from one year decomposes and disappears in the course of the following wet monsoon. The lamtoro seed is planted directly in the teak forests without interval in the rows so that it becomes an erosion resisting hedge. The lamtoro foliage is sometimes cut as green feed for livestock and the small beans are occasionally used for food.

The Forestry Service of the Ministry of Agriculture is responsible for the management of the Government teak forests and follows a careful program of selective cutting until the trees are nature. The process of selective cutting, with the trees of poorest quality being removed at five to ten year intervals, gradually produces a forest which has little appearance that it was once planted in regular rows. The wood removed from the forests in the process is sold as firewood or may be utilized for low grade lumber. The top grade teak lumber is obtained from the selected trees which mature at the age of fifty to seventy-five years.

On the Sumatra east coast is found the second type of teak culture, which is a supporting enterprise of the tobacco

estates. The tobacco in this area is air dried in large sheds covered with thatched roofs. The framing of the sheds not only supports the vast roof area but also supports the tremendous weight of tobacco hung in the sheds for curing. Teak poles are the best material found by the tobacco estates for the framing members of the sheds because they are thin, strong, resistant to termite damage, and economical. The tobacco estates formerly were able to produce their own teak poles in groves where the trees were planted at intervals of no more than six feet. In such plantings the teak tree will attain a height of thirty to forty feet with a breast-height-diameter of no more than six inches.

Some tobacco estate personnel have expressed their anxiety over a shortage of teak poles for the next few years. Formerly, the estates planted their teak groves as road borders so that transportation of the poles would be easy, however, these road borders are now often being occupied by squatters who cut the teak trees for firewood. At the present time plantings in the more remote areas of the estate holdings are being made, areas not so attractive to the squatters, but until these areas are ready for harvest, there may be a shortage of poles for the curing sheds.

M. Tobacco

It is thought that tobacco was introduced in Asia by the Portugese and reached Indonesia late in the Sixteenth

Century[1] but had no importance other than for domestic consumption until about 1870. Prior to 1870 there was a small amount of tobacco exported from Central and East Java, but since the establishment of the Sumatra wrapper leaf industry in the vicinity of Medan on the northeast coast of Sumatra, this area has been the largest source of tobacco for export. The total production of Java and Madura is greater than that of Sumatra, but most of the Java and Madura tobacco is used for domestic production of cigarettes.

In addition to domestic cigarette consumption the Indonesian people use large quantities of tobacco for chewing. Tobacco consumed in this manner is not the processed plug type used in the United States but normally is shredded tobacco which the people mix with betel nuts (Areca catechu), gambier (Uncaria gambier) leaves, and often with lime in a mixture known locally as sereh. In sereh, tobacco and gambier leaves or tobacco and betel nuts are commonly used but the complete mixture is preferred. The mixture of these materials dyes the lips and gums a vivid red ordinarily attributed to the betel nut but due at least in part to the gambier leaves. Formally sereh was used by almost all Indonesians, but today its use is not common among the educated people.

There are three distinct types of tobacco culture in Indonesia. In the Deli area in the vicinity of Medan,

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1. Vlekke, op. cit., pp. 275-276.

production is concentrated in the seven companies which controlled concessions of 48 estates before the war, on which the Sumatra wrapper leaf tobacco was and is produced[1]. In this area a total of over two million acres was in estate concessions, but tobacco was never planted on more than two to three percent in any one year. A large part of the area was in other estate crops and the remainder held in reserve. On Java the so-called estates might be more accurately described as processing corporations which contracted with farmers to produce tobacco for them and furnished the seed or plants for the farmer to use in his fields. Some of the Java estates also hold land on long term leases, but these lands must be returned to the people for food crop production when not planted in tobacco under conditions similar to those of the sugar estates.

Tobacco production by farmers is common throughout the country, but with the exception of Central and East Java and Madura, little of this tobacco finds its way past the local market. In Java and Madura the farmers produced 77,000 short tons annually prior to the war and the 1950-51 production was 27,500 tons. A portion of this is sold to the estates for processing, but an increasing number of cooperatively owned barns for air drying and for flue curing, as well as auction barns, are being constructed by the farmers.

1. Metcalf, op. cit., p. 59.

The Sumatra wrapper tobacco is grown normally in an eight-year rotation of one year in tobacco followed by seven years fallow, during which time the fields are covered by second growth forest. In some cases the land may be planted in rice or another food crop by the estate laborers before native vegetation is permitted to take over. In the early days of the tobacco estates most of the land clearing for tobacco followed the native pattern of land clearing with fire and ax, but the soils were much better prepared prior to tobacco planting than by the people for their food crops. Prior to the war because of a general shortage of labor in the Deli area the estates began mechanizing their land preparation, a trend which has been continued since the war because of the increased cost of labor and labor troubles.

The present practice is to remove the largest trees and pile them by means of bulldozers and root-rakes until dry enough to burn. The piled trees, brush and smaller vegetation are then burned, and after the land is plowed to a depth of twelve to twenty inches by the use of the largest types of crawler tractors and heavy disc plows, it is harrowed two or three times prior to transplanting. The tobacco plants are started in nurseries and are transplanted by hand and also generally cultivated by hand, although a few row crop tractors are being used for cultivation by some estates.

The emphasis in the Sumatra wrapper tobacco industry has always been on the production of premium grades of tobacco. The agricultural scientists state that this particular type of tobacco can only be produced upon freshly cleared lixivium temporarily enriched by the humus residue from forest growth. Because of the abundance of fertile soils in this area and the concessions that could be obtained from the Netherlands Indies Government, the estates could follow this cropping practice without difficulty. The estates maintain soils laboratories and have specialists in agronomy and soils whose knowledge of tobacco and soils enables fertilization for the highest economical production. Fertilizers must be used with extreme caution, however, to maintain the quality of the tobacco.

In the immediate future the estates must modify their cropping system or must reduce the area planted in tobacco. The population of the area has increased to such an extent that instead of the pre-war surplus of food crops there is a deficit so that there is an increased demand for land for the people to cultivate for food crops. There is also a demand from the people to the Indonesian Government for the cancellation of estate concessions and the return of at least a portion of these lands to the people. As stated in the section on rubber production, the Government is in a very difficult position of having to effect a compromise between the demands of the population while trying to honor

the concessions of the estates granted by the Netherlands Indies Government which the Indonesian Government is obligated to honor under the terms of the Round Table Conference. In 1952 a compromise was arranged under which at the last report almost 400,000 acres of former estates concessions were given up by the estates for distribution among the people. In this compromise agreement most of the lands given up by the estates were actually already illegally occupied by the people so that the estates were in effect giving up land over which they no longer had control and which the Government authorities could not return to the estates.

In the compromise agreement, however, some transfers of squatters from lands retained by the estates was necessary, and even though the Government through its social welfare service paid the farmers for the loss of their crops, the resettlement became the source of more trouble. Some 35 miles south of Medan in March 1953, when the Government attempted to force the removal of squatters by the destruction of the bamboo houses with a bull-dozer, police protection was necessary for the tractor operator and in the riot that followed five farmers were killed. According to newspaper reports the five farmers were actually Chinese who had entered the country illegally from Malaya, but for the politicians and newspapers opposed to the Government it was another basis for outbursts against foreign capital.

In contrast to the Sumatra tobacco culture the Java estates and the commercial tobacco producers among the small farmers of Java and Madura utilize land which remains in continuous cultivation. Tobacco is not usually planted in the same field more than every second or third year; in the interim period corn, cassava, potatoes, peanuts, and green manure crops are planted. Rice is also planted between the tobacco crops, but the other crops are more common because of limited rainfall and irrigation facilities, especially in East Java and on Madura. Fertilizers are used by the estates, but their use by the farmers is the exception rather than the general rule. In the dry monsoon the tobacco is irrigated when rainfall is inadequate if at all feasible, even though water must be carried in primitive buckets for considerable distances as is shown in Figure 56. With few exceptions the land preparation for tobacco on Java and Madura is accomplished by the use of animal-drawn plows and harrows. Some land is prepared by the use of the heavy hoe only, and a small amount of land is prepared by means of tractor power on the estates. The men ordinarily prepare the land, and the transplanting from the nursery beds and the cultivation of the crop is the work of the women and children.

Throughout Indonesia tobacco production by farmers, except as described above, is secondary to food production and receives little attention. A few tobacco plants may be

Figure 56. Watering tobacco with Palmyra palm leaf container on Madura

Figure 57. Bamboo scaffolding

Figure 56. Watering tobacco with Palmyra palm leaf container on Madura

Figure 57. Bamboo scaffolding

planted at scattered intervals through a field planted in some other crop, or a few plants may be planted in the edge of a field or near the farm houses. Except on Sumatra, Java, Bali, and Lombok few farmers plant little more than enough tobacco for the use of their families for home-made cigarettes or in *sereh*, but if there is a small excess it is usually shredded, dried, and sold in the local market.

The Java estates tobacco includes some wrapper, filler, and binder tobacco, but the largest proportion of tobacco production other than the Deli area is either *krosok* or *kerf* tobacco. Prior to the war some *krosok* and *kerf* tobacco was exported, but to conserve foreign exchange that would be used to purchase Virginia and other types of tobacco for blending with other tobaccos in the domestic cigarette industry, the import of these tobaccos has been restricted and the export of the *krosok* and *kerf* prohibited. The domestic cigarette industry produces two types of cigarettes, the conventional machine rolled cigarettes which are common throughout the world and the *kretek* which is peculiar to Indonesia. The *kretek* is tapered, and when smoked makes a popping sound because cloves have been mixed with the tobacco. It is to this sound that Indonesians attribute the name *kretek*, and it is because of the strong clove aroma that many people prefer this cigarette.

N. Miscellaneous Tree Crops

The products of the trees and shrubs previously discussed normally are the products of cultivation and careful attention. The products of the trees discussed in this section are normally obtained by the exploitation of the natural resources of the forests of the country and require little, if any, attention from the inhabitants other than the effort of harvesting, some processing, and removal to communication routes so that they may be marketed.

Nutmeg (Myristica fragrans) and clove (Eugenia fragrans) are trees native to the Moluccas and are the principle source of the products for which the Archipelago received its ancient name of the "Spice Islands". The trees grow under the cover of the tropical rain forest and reach the height of fifty feet or more. The clove tree yields two products; the clove itself is the dried base of the flower bud, but the more valuable product is the flower itself. Both the blooms and the cloves are picked and air dried prior to marketing with the price per unit of weight of the dried flowers being approximately twice that of the cloves. The flowers eventually find their way to the perfume industry, while the cloves more often are used in foods or pharmaceuticals.

As indicated by its name, the nutmeg is the nut of the tree and in appearance is similar to the hickory nut of

North America. Because the outer hull of the nut is dry at the time of harvest, no drying or other treatment is necessary prior to marketing. While the nutmeg and clove trees are native to the Moluccas and propagate themselves naturally, they are often started in nurseries and later transplanted to the forests. Through the activities of the Farmers' Agricultural Service they are being planted in other areas of Indonesia besides the Moluccas at this time.

Throughout the Archipelago there are many species of eucalyptus which yield an oil valued very highly by the people for its medicinal properties. When used externally, the oil is described as having a heat-producing effect and is the home remedy for colds, neuralgia and muscular aches used in a manner similar to the mustard poultice so common in the southern part of the United States a few years ago. In addition to the oil some varieties of eucalyptus, which are similar in appearance to the sycamore tree in that its bark peels off leaving a white under bark exposed, yield a fibrous bark which is highly valued by the native boat builders as a caulking material. The bark is pounded, treated with a gum, and used for caulking between the boards added to the sides of the dugout canoes in order to obtain sufficient freeboard for use in the open seas.

There are many types of trees throughout the country which yield valuable resins and gums, but the greatest concentration of these is in North Sumatra where turpentine, camphor, dammar, and capol are produced, the latter two being products of Agathis alba. Dammar is the resin harvested by tapping, while capol is obtained from stumps. This area has long been noted for its gums which from ancient ages were valued very highly throughout the Far East for their fragrance. Pine (Pinus merkussi) has been planted by the Forestry Service in its reforestation and afforestation efforts in North Sumatra which are being continued. Sufficient quantities of pine are already available to provide the raw material for a paper industry when the hydro-electric potential of the area is developed to provide the necessary power. In the meantime the Government Agricultural Estates is already working 92,500 acres of pine forest for turpentine production[1].

Two other products from the forests of Indonesia are cinnamon and tannin. While the former comes from Cinnamon Cassia, the latter is from the bark of several species of trees. Both are harvested in the same manner, although their end use is quite different; the trees are cut when they have a diameter of about two inches, and the bark is stripped from the trunk, after which it is sun dried and marketed. The barks which yield tannin usually are put through an extraction process and the resultant tannic acid

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1. Saksono Prawirohardjo, Sekedar Mangenai Organisasi Dan Usaha Pusat Perkebunan Negara, Almanak Pertanian, (R. Soetijo, Editor), Kementerian Pertanian, 1952, pp. 303-316.

is available to the leather industry. While tannin may be obtained from the bark of many trees, the mangrove is one of the most productive. This tree grows in the tidal swamps of Sumatra, Kalimantan, and Sulawesi -- the principal sources of the product.

Rattan is another product of the forests and is found principally in the lowland forests of Kalimantan and Sulawesi. After it is made into furniture, it has the appearance of bamboo when in reality it is of the palm family of the genera Calamus or Daemonorops, and in the forests it virtually covers the trees as it climbs over them. The process of harvesting this palm is to cut the vine at the ground and wait until the plant is almost dry so that the many thorns on the vines may be knocked off along the leaves as the vines are pulled from the trees. In this condition the rattan is reasonably flexible and may be folded into large bundles. The individual pieces of rattan are often 75 to 100 feet in length, and the size varies from one-eighth inch in diameter to as much as two inches. When rattan is dry, it is rather stiff but may be bent after heating with a flow torch so that it is readily shaped for all types of furniture frames; after cooling, it again becomes stiff and will retain its shape to form an attractive furniture frame that is well adapted to the climate and conditions of the tropics.

In the rain forests of Sumatra, Kalimantan, and Sulawesi

are found the iron wood (Eusiderocylon Zwageri) trees, a source of much valuable timber of construction but one which must be used locally because of limited transportation facilities and the expense of moving it to other areas on a large scale. The texture of the wood is so coarse that it cannot be finished with the smoothness required for furniture, although it is so dense that the green logs or lumber will barely float. Although the iron wood lumber is worthy of its name when seasoned, it can be processed satisfactorily when green, and because of its resistance to fungi and to insects it is very highly valued for the framing of houses, as a roofing material, and for the heavy timbers of bridges and dams. Under water its life is unknown and even as a roofing material it will last for generations. While travelling on Kalimantan a government official pointed out a house constructed by his great-grandfather, on which the original iron wood shingle roof was apparently in perfect condition.

In the forests of Sulawesi the macaramba or Macassar ebony (Diospyros) is found, and the value of this wood is such that in spite of the difficulties of transportation it finds its way into the trade channels of the world. This is not the true black ebony of Asia and Africa but is mottled with streaks of reddish brown similar in appearance to the mottling of some types of asphalt tile flooring material commonly used in America. Because of its denseness and fine grain this wood is valued for the fine finish it can be given, and it is used for furniture, panelling, and other fine wood work. In highly polished panelling it has the appearance of a strange kind of marble at a casual glance, and only upon very close examination can one be sure that it is wood.

In a strict botanical classification bamboo should be classified as a grass, but from the standpoint of its characteristics of growth and from the standpoint of its utilization, the Indonesian bamboo may be properly discussed among the miscellaneous forest products. Bamboo is the most important construction material for the people outside of the cities, and it is also used to a considerable extent even in the so-called Western type construction, either for scaffolding during construction or repair (Figure 57) or for walls or ceilings in the finished building; in the latter cases the woven bamboo is usually either painted, or papered and then painted.

Bamboo also is a source of food; the young bamboo shoots are used as a vegetable and, while not so attractive to people unaccustomed to them, are considered a delicacy by those who have acquired a taste for them. By far the most important uses of bamboo, however, are in the fulfillment of the daily needs of the people. As a material of construction the only tool that is needed to utilize the bamboo is a sharp, heavy knife, and it is likely that the workability of the material, as well as its availability, accounts for its importance in tropical living.

Bamboo requires no particular attention; it may be planted in the kampongs to provide the needs of the local people, but more commonly it is a native plant found along the banks of streams, and in some areas it has crowded out less adapted vegetation so that there are literally forests of bamboo. To the average American who has known only the small species of bamboo that are good for fishing poles or the slightly larger species that are used as ornamental screen plantings, the species of bamboo that are as much as six to eight inches in diameter and which attain heights up to fifty feet will remain a curiosity.

The smaller species of bamboo furnish the material for the pikulans or carrying poles; the larger species furnish the framing material for buildings; all sizes, when split into small, thin strips, furnish the material for beds, floors, walls or screens, for simple tools, and for weaving into containers of all conceivable types and shapes. The fact that paper is scarce and expensive makes the use of loosely woven containers from thin strips of bamboo more economical than the use of paper bags. The simple dwellings and all of the furniture of the rural population are often constructed entirely from bamboo with the exception of the thatch roof which is normally from the leaves of one of the palms. The many uses of bamboo are indicative that the Indonesian people have, just as other peoples of the world, adapted their customs to their environment because of the economics involved in the supply and demand, in the ease of working with available tools, and in the effective life of various materials of construction.

CHAPTER XI

THE ORGANIZATION AND FUNCTIONS OF THE MINISTRY OF AGRICULTURE

The schematic diagram of the organization[1] of the Ministry of Agriculture in Figure 58 shows the principal sub-divisions of the Ministry[2] in April 1953. The general organization is very similar to the organization inherited from the Netherlands Indies Government, but the process of reorganization is an almost continuous process as the Indonesians gain experience and modify sub-divisions or change functions to meet current problems and capabilities. The grouping of most of the sub-divisions under general headings of Agricultural Services and Research Agencies should not be interpreted to mean that these groups constitute a major sub-division when in fact the head of each Division, Service, or research agency is generally directly responsible to the Secretary-General, although there is nominally a coordination plan.

The Minister of Agriculture is the executive head of the Ministry and is responsible for the coordination of agricultural activities in relation to the overall program of the government as established by the Cabinet. In the promulgation of the government program the Minister is

1. Tandiono Manoe, Peraturan Menteri Pertanian, Kementerian Pertanian, Djakarta, 1951, Mimeograph, pp. 1-17.
2. R. Soetijo, op. cit., pp. 69-92.

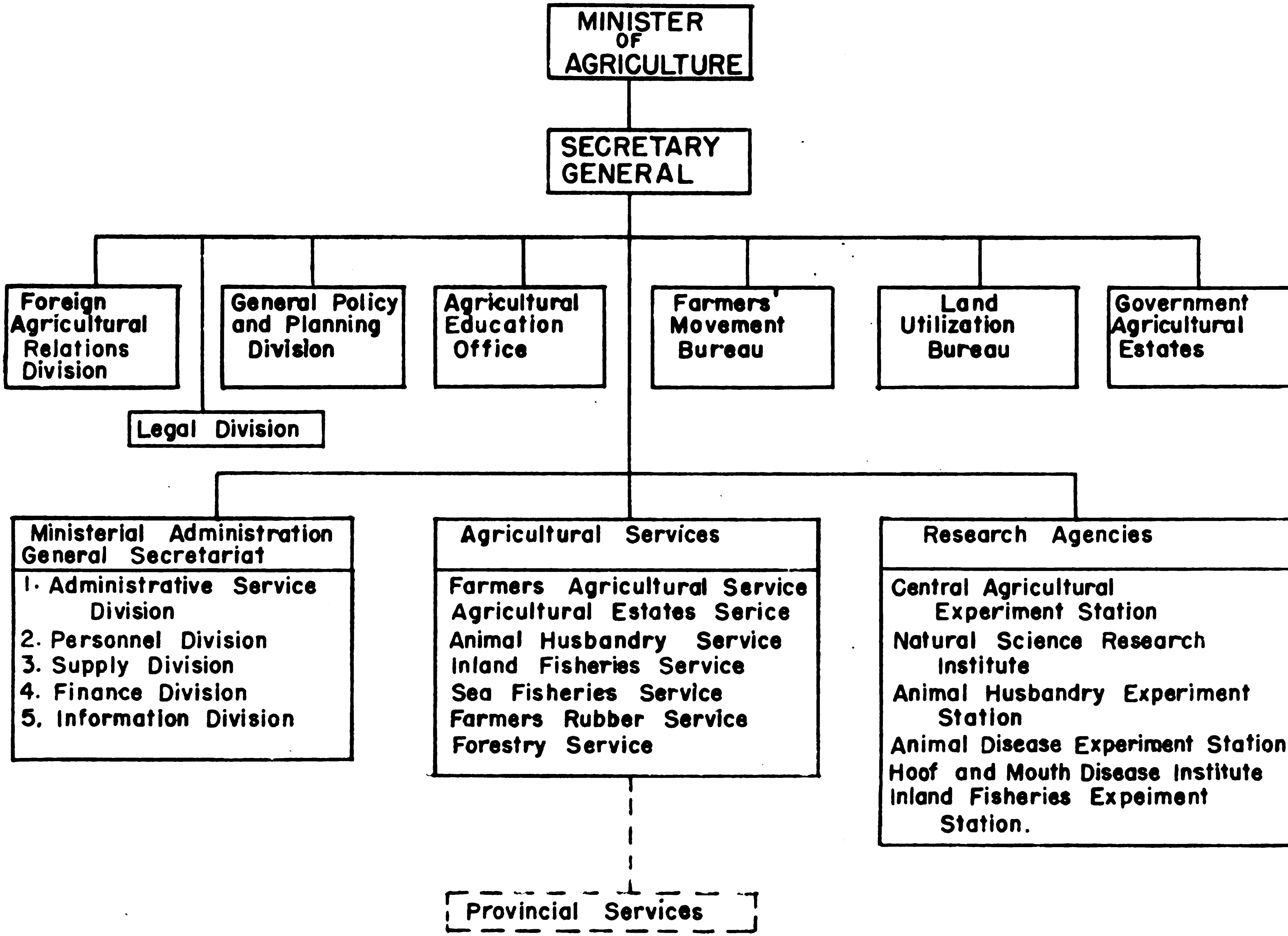

FIGURE 58 SCHEMATIC DIAGRAM SHOWING ORGANIZATION OF MINISTRY OF AGRICULTURE

responsible, with the other members of the Cabinet, to Parliament and to the President. If the Cabinet is a coalition cabinet, the Minister is also responsible to his political party for the implementation of the party objectives in agriculture and in other fields as established at the time the overall program of the Cabinet is developed.

OFFICE OF THE SECRETARY-GENERAL. The Secretary-General is the principal administrative officer of the Ministry of Agriculture and conducts the routine affairs of the Ministry within the limitations of the general policies established by the Minister.

FOREIGN AGRICULTURAL RELATIONS DIVISION. The Foreign Agricultural Relations Division maintains contact with agricultural agencies of other governments and collects information pertinent to the agricultural economy of Indonesia, especially information about the world market as the supply and demand affect Indonesian export commodities. One section is responsible for making all arrangements for Indonesian personnel to go abroad for training in the agricultural and closely related sciences. This same section is the office of the Ministry which is responsible for the detailed arrangements related to economic or technical assistance from abroad from the United States, through the Technical Cooperation Administration, from the United Nations through its several agencies, and from the nations of the British Commonwealth through the Colombo Plan.

LEGAL DIVISION. The Legal Division of the Ministry has two principal sections, one for the promulgation of regulations pertaining to foreign agricultural relations and the second for domestic regulations. In addition to these activities the Division is the legal advisory agency of the Ministry on matters pertaining to existing or pending legislation.

SUPPLY DIVISION. The Supply Division also reflects the influence of the agricultural export-industrial import economy of Indonesia in its division into sections for domestic purchases and for purchases from abroad. Although this agency may sometimes contract with vendors for necessary commodities, its principal function is to process the requisitions of the various agencies for transmittal to the Government Central Purchase Bureau.

AGRICULTURAL EDUCATION OFFICE. The most important function of the Office of Agricultural Education is, perhaps, the operation of the six agricultural high schools established and maintained by the Ministry of Agriculture, three located on Java, two on Sumatra, and one on Sulawesi. While resident directors are responsible for the daily operation and administration of these schools, the above office is responsible for the establishment of curricula and regulations, for the employment and assignment of teachers, and for the general supervision of the schools. These agricultural high schools have no direct relations with the Ministry of Education and other organizations which may be concerned with agricultural education. In the last named function there is also a responsibility for cooperation with local government or private agencies which conduct any courses in agriculture.

Based upon a study of the curricula of the agricultural high schools, the author feels that students successfully completing the curricula have the equivalent theoretical training of students completing junior agricultural colleges in the United States, even though they have attended school for only twelve years and their ability to apply this training is deficient because of their lack of farm background and the dearth of practical training in the schools. As an example, the theory of surveying as taught includes the use of transits with an allocation of eighty hours for the course, of which only about fifteen hours are laboratory practice. This is ordinarily considered a sophomore course in engineering colleges of the United States, with the theory being covered in fifty to sixty hours of classroom work and with approximately an equal amount of time required in field practice. The surveying course normally taught as a sophomore course for students in the agricultural college curricula, except forestry, in the United States does not ordinarily go beyond the use of the engineer's level.

Although the general educational system of Indonesia has been discussed in an earlier section and the schematic diagram of Figure 2 shows the relationship of the agricultural high schools in the general system, it should be commented upon again at this point. These high schools are considered technical trade schools to teach agriculture as a vocation rather than being considered as preparatory for entrance in the agricultural colleges. It is normally expected that students who plan to attend college will attend the general high schools, even though they may plan to study agriculture. The agricultural high schools are considered as the completion of a man's formal education, and most of the graduates go directly into the Ministry of Agriculture, but some are employed by the estates; very few are able or inclined to undertake farming as a business except for the negligible minority whose families have enough land to permit a son to join the family enterprise. Very few of the students in either the agricultural high schools or colleges have ever actually worked in the fields. This system still follows that which was established by the Netherlands Indies Government, and it was apparently designed for the purpose of supplying the sub-professional employees to assist the Dutch Agricultural College trained employees of the Government and of the estates with little idea that these high school graduates would eventually fill the positions of more responsibility for which more advanced training was necessary. The system has already been modified to some degree and probably will be changed even more in the next few years. School attendance is encouraged through a large number of scholarships from the Government, and there are also some grants awarded by private enterprise. Attendance is further encouraged by the reduction of fees per student if more than one student from a farm family is enrolled.

Excluding the agricultural high schools and the agricultural faculties (colleges) of the two universities, there are a total of 28 different courses[1] taught by the various sub-divisions of the Ministry of Agriculture. Most of these courses are the responsibility of the various Services, and they vary from two to four hours per week of the six months' courses for farmers taught by the Farmers' Agricultural Service in 800 different places to the four-year course in sea fisheries conducted by the Sea Fisheries Service in one location only. The Agricultural Education Office is the coordinating office for the educational offices of the Ministry and must try to correlate all such training with the capabilities and facilities of Ministry with those of the Ministry of Education so that there is as little unnecessary duplication as is feasible at this time.

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1. Ibid., pp. 109-127.

FARMERS' MOVEMENT BUREAU. The objective of this bureau is to encourage and assist the farmers of the country in the solution of their own problems through individual and community effort. While to a certain degree this objective is identical with the overall objective of the Ministry of Agriculture, this bureau is specifically concerned with the education of the people and with the problem of assisting any farmers' group in organizing, whether the objective be for production, consumer, credit cooperatives, or any other worthwhile purpose. Thirty-two farmers' organizations are listed in Almanak Pertanian 1953[1]; some are national organizations with branches in almost every province, while a few are local organizations.

LAND UTILIZATION BUREAU. The Land Utilization Bureau was established to collect available information upon which to formulate basic concepts of rational land use with conservation of the soil resources of the nation to be the first and most important consideration. A number of agricultural officials have expressed the opinion that this bureau will become the Soil Conservation Service of Indonesia and will be patterned after that service of the United States. Others have expressed the hope that this bureau become a research and advisory board to provide the basic doctrine of proper land utilization with the implementation of such doctrines to remain the responsibility of other

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1. Ibid., pp. 129-139.

agencies which already have large numbers of men working in the field throughout the Archipelago. Until this time (1953) the Bureau has directed the conduct of a number of small research projects, including some of the small watershed type, and has collected portions of other research work applicable to developing initial concepts of how soil erosion control work should be initiated on a large scale.

GOVERNMENT AGRICULTURAL ESTATES. The Pusat Perkebunan Negara or Government Agricultural Estates is in effect a Governmented owned corporation charged with the management and operation of the 22 estates[1] that were the Government agricultural enterprises before the war and the 18 estates which were owned by enemy nationals or corporations and were confiscated by the Government after the war.

One phase of the operation of this organization is the management of the 22 estates for profit; the second phase is the development and rehabilitation of the confiscated estates or the development of new enterprises on Government owned lands. The 22 estates are producing rubber, tea, copra, resins, and palm oil, while the new developments will also produce pulpwood and rice. Because of the large scale use of field machinery and processing equipment, the Government Agricultural Estates are directly concerned with more different applications of agricultural engineering than any other agency and will therefore be discussed more fully

1. Saksono, op. cit., pp. 308-309.

in a later section.

AGRICULTURAL ESTATES CONTROLLED BY THE REPUBLIC OF INDONESIA. In the area of Surakarta, Central Java the agency, Agricultural Estates Controlled by the Republic of Indonesia, is responsible for the management of the estates producing sugar, tea, coffee, rubber, and hard fibers.

AGRICULTURAL SERVICES. The preceding discussion of divisions of the Ministry of Agriculture has been concerned with the divisions responsible for the policies and the administration of the Ministry. The above divisions have few direct contacts with the people; however, they support the operations of the Services and Institutes which conduct the necessary research and disseminate the information to the farmers through their various action programs. The Services and Institutes are autonomous or semi-autonomous but are organized so that with the coordination within groups and between groups an effective implementation of programs is possible. As shown in Figure 58 there are groups of services in five major fields: Farmers' Agriculture, Estate Agriculture, Fisheries, Animal Husbandry, and Forestry. There is some duplication of efforts because of these lines of division, but cooperation and coordination are facilitated by the personal acquaintance and mutual respect between the principal officers of all of the services as a result of their having completed the same agricultural

high school at Bogor, the only agricultural high school in Indonesia until just prior to the war. The Agricultural Faculty (college) at Bogor was not operative long enough before the war for anyone to graduate; the only personnel of the Ministry with college degrees are the very few who were able to attend Wageningen Agricultural Faculty in Holland. Because there are now six agricultural high schools and two agricultural faculties, this close personal relationship will disappear as the present officials retire.

FARMERS' AGRICULTURAL SERVICE. Although not included in the title Djawatan Pertanian Rakjat, this Service includes the Indonesian equivalent of the Agricultural Extension Service of the United States and has frequently been called by this name in English. As shown in Figure 59 the organization of the Extension Service extends further than its American counterpart and has employees at the sub-district (3 to 5 villages) level rather than stopping at the county level as in the American organization. The principal differences in the two systems are the absence of specialists on the staff of the Chief of the Service and on the staffs of the Provincial Inspectors (Directors) and the absence of home economics extension work as such. The lack of specialists may be attributed primarily to the lack of trained personnel whose duties may be so limited that they can become specialists and secondarily to the agricultural education system which, patterned after the European system,

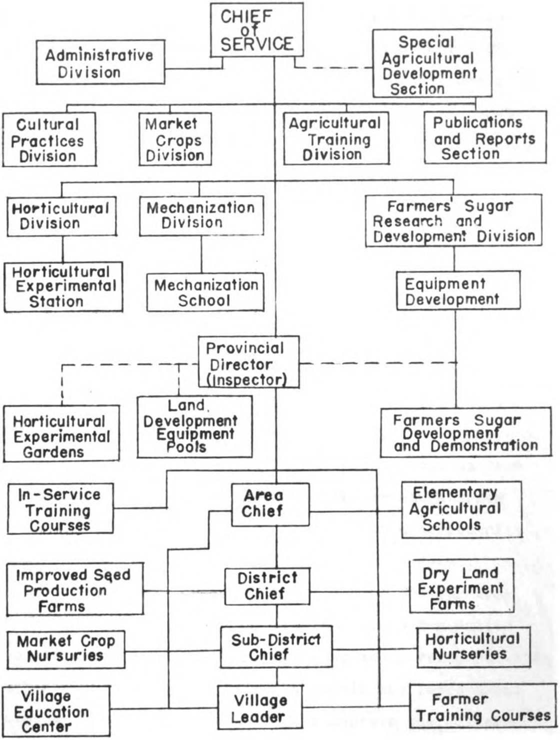

FIGURE 59. SCHEMATIC DIAGRAM OF ORGANIZATION OF FARMERS' AGRICULTURAL SERVICE.

does not permit any appreciable degree of specialization at levels below the equivalent of work for the Master of Science degree. However, by virtue of experience some of the personnel have been and are becoming specialists, but usually their duties are of a general nature. It is likely that as personnel becomes available from the enlarged educational program, more sub-divisions will be formed in the Service just as the Horticultural Division was formed under the Netherlands Indies Government, the Mechanization Division in 1951, and the Division of Export Crops in 1950.

The Training Division of the Service is responsible for the organization and the supervision of training courses established by the Service, courses given for farm youth and adult farm people and in-service-training for employees of the Service. The duration of these courses varies from one to two hours weekly for the adult farmer courses for three to six months to full time courses for a period of one year in the mantri courses.

The objective of the extension phase of the Farmers' Agricultural Service is exactly the same as in the United States: to carry educational programs to the rural population through non-resident instruction to permit the improvement of farmers' agriculture and therefore improve the welfare of the majority of the Indonesian population. The media utilized are also the same, although the Indonesian extension worker must rely more on visual aids and field demonstrations

than upon bulletins because of the low literacy level of the rural people. While home economics is not such a distinct part of the Service, some instruction is conducted for the farm women and girls by the extension workers especially directed at the preparation and serving of food to provide a better balanced diet.

The inadequacy of commercial channels of supply for improved seeds, fertilizer, and tools has made it necessary for the Extension Service to serve as a distribution and retail outlet for essential commodities. In some areas these essential commodities would not otherwise be available, but in others the lack of competition between retail merchants has resulted in exorbitant prices. This function of the Service has also made it possible to introduce fertilizers at prices subsidized by the government into areas where they had not previously been used. The same procedure has been used for some new or improved implements. A major problem faced by the Service, as with every other agency of the Government dealing with the residents of rural areas, is the lack of transportation, Similarly, the need of demonstration farms is multiplied by the farmers' inability to visit farms beyond walking distance. The average farm being at most two or three acres, the large number of farmers makes it impractical for the Service to attempt to provide transportation to carry farmers to demonstrations located farther away.

Because of the wide variety of conditions found in the different provinces, the methods of conducting the program of the Extension Service vary, but there are three phases of the overall program that are common to all provinces. In every province the Service has, and is establishing more every year, Balai Pendidikan Masjarakat Desa (Village Education Center), Seed Farms, and Dry Land Demonstration Farms. Table V shows the number of establishments in operation, and the number under construction in March 1953, and the total number to be established under present plans.

The Village Education Center consists of five to ten acres of demonstration fields and a building which has a room for meetings or classes and another room for display of model farms, farm implements, samples of seed, and fertilizers. Usually there are also office space and living quarters for the mantri in charge of the Center. These Centers are established primarily for agricultural extension work but are also used by other agencies of the Government in other extension programs. The mantri conducts courses for girls, boys, women (Figure 60), and men in various subjects as required to meet local needs. The architecture of the Centers is adapted from that of local customs as shown in Figure 61.

Surrounding the Centers are small demonstration fields for various crops and practices with the most attention normally being given to irrigated rice production. Small

TABLE V

EDUCATION CENTERS, SEED FARMS, AND DEMONSTRATION FARMS OF DJAWATAN PERTANIAN RAKJAT[1]

	Complete Jan. 1, 1952	Under construction 1953	Total planned
Education Centers	167	78	1,400[a]
Seed Farms	216[b]	7	220
Dry Land Demonstration Farms	115	-	250

1. Kadar Marwani, Personal Communication, June 9, 1953.
a. Number approximate, objective one in each district.
b. Includes 103 farms established before the war, 113 new farms.

Figure 60. Women's class in Central Java village education center

Figure 61. Central Sumatra village education center with Minangkabau design

plots are planted to several varieties of locally adapted rice; within the varieties the practices are varied so that the people of the community may see the advantages of the best varieties and practices. The Centers not only serve as educational and demonstration centers but also are used as sales outlets for the seed, fertilizers, and implements handled by the Service. Local variations in the operations of the Centers occur to meet local requirements; for example, near Madiun, East Java the Center operates a small motor driven cane crushing mill and has evaporating pans so that the farmers of the area may bring their sugar cane to the Center, grind it, and make their own sugar. The mill is operated by men employed by the Center for that purpose, but the evaporation is done by the farmers under the supervision of the <u>mantri</u>. This operation is self-perpetuating in that the farmers give the Center one-sixth of their brown sugar as payment for the use of the equipment. This function of the Center bears a close similarity to some of the community canning centers operated in the United States, in connection with the Smith-Hughes Vocational Agricultural Education Program in rural high schools.

The seed farms operated by the Service serve as field increase plots for improved varieties of seed developed at the agricultural experiment stations. These farms are strategically located so that eventually there will be a

seed farm for each 25,000 acres of crop land. The program of distribution of improved varieties of crops will operate as follows: Seed of varieties which prove their value at the experiment stations will be distributed to the seed farms for planting and will be tested under the local soil and climatic conditions; the seed of varieties which are locally adapted will then be sold to farmers who agree to produce crops for seed; these farmers will repay the seed advanced by the seed farm in kind and sell their remaining production to farmers in their vicinity and the seed farm will also sell the seed repaid by the seed producers to other farmers in the vicinity. When the program is in full operation, it is expected that all farmers will be able to have seed of improved varieties, usually only two years from the breeder and in all cases only three years from the breeder.

The Dry Land Demonstration Farms are being established throughout the country in areas where lack of irrigation facilities have retarded agricultural development. These farms are usually from ten to fifteen acres in size, the size that is considered necessary to permit a sedentary agriculture to be established. These farms are operated as family units under the supervision of a _mantri_; food crops, upland rice, corn, cassava, sweet potatoes, peanuts, and beans are planted in rotation with green manure crops in order to control erosion and to maintain soil fertility.

In this program, as with all others, there are variations to meet local needs and conditions; for example, on the island of Sumba the Service has obtained the cooperation of twelve families in the establishment of a model village where improved methods of dry farming and improved housing are being demonstrated. In this area there are many small villages high in the hills with little attention given to crop cultivation. The people tend their livestock on open range and depend upon small areas under ladang culture for corn, cassava, and the small amount of rice that they are able to produce. It is in this area that land preparation is often accomplished with dibble sticks in spite of the fact that cattle may be grazing in an adjacent area. The twelve families of the village work cooperatively under the supervision of a mantri with time allocated for field work, care of livestock, and other daily chores. The men work together using their cattle as draft animals for plowing and harrowing the fields. Although the field work is performed cooperatively, individual ownership of the land, crops, livestock, and homes is recognized. The establishment of this village was made possible through the efforts of the Farmers' Agricultural Service, the Animal Husbandry Service, and the Radjah who allocated 125 acres of land for the use of the village.

The Division of Mechanization of the Farmers' Agricultural Service is responsible for the operation of a program of land development with machinery which will accelerate the establishment of sedentary agriculture in the sparsely populated areas of the Outer Provinces and increase food production on Java through better, and more timely land preparation. The Division also serves in an advisory capacity to other agencies of the Ministry of Agriculture on problems pertaining to agricultural machinery and to the Central Import Office when that office receives requests for licenses for the import of agricultural machinery.

Since July 1952 the Division has operated a school for instruction in the operation and maintenance of tractors and machinery for personnel who will subsequently be assigned to pools of equipment for field operations. In December 1952 an American agricultural engineer was assigned as technical assistant for the school to assist in the instruction and the direction of the school under a cooperative project with the Technical Cooperation Administration.

The Horticultural Division of the Farmers' Agricultural Service is responsible for making available to the Service information on the production of fruits and vegetables and is also responsible for the operation of the Horticultural Experiment Station, at Pasar Minggu, ten miles south of Djakarta. In addition to the experimental field work normally expected at such an experiment station, the Division is also charged with the responsibility for conducting research in the preparation and processing of food. From the Experiment

Station the Division distributes planting stock for sale to farmers through the Service and also provides material for the nurseries of the Service throughout the country. The Horticultural Experiment Station was established in 1921 and now has slightly more than two hundred acres in plantings of various fruits and vegetables.

The Division of Export Crops has the responsibility of providing to the Service information relative to the production of farmers of crops primarily intended for export, such as coffee, tea, pepper, ramie, rosella, and others, with the exception of rubber. Almost invariably these crops must undergo some processing prior to marketing or domestic consumption, and in plans for production this Division must maintain close liaison with the Division of Small Industries of the Ministry of Economic Affairs. An example of the function of this Division is illustrated in its participation in the initiation in 1952 of a program to expand the production of ramie. This crop is valued for its strong fibers, especially useful for twine which the Indonesian fishing industry needs in large quantities, but it may also be used in textiles. The production of this crop on a commercial scale would help to fill Indonesian requirements and would also provide the raw material for a new industry to contribute to the country's need for industrial development. The Division prepared plans for the distribution of root stock for planting on an experimental basis

in fields of two to ten acres and dispersed it through all the provinces where information on soils and climate indicated probable success for the crop. The available root stock was from the branch experiment stations of the General Agricultural Experiment Station and from residual plantings near Medan during the years of the Japanese occupation. Simultaneous with the preparation for the distribution and experimental plantings, the Division cooperated with the Small Industry Division to insure that the fiber produced could be processed sufficiently to permit its barter for completely processed fibers from other countries already engaged in ramie processing until facilities for the complete processing can be installed in Indonesia.

The Documentation Division has as its principal function the publication of the monthly magazine *Madjallah Indonesia* with its articles primarily of interest to the Extension Service. In addition to this principal function the Division also assists various staff members with the publication of timely bulletins and with the preparation of articles for publications besides *Madjallah Indonesia*.

The Records Division, as indicated by its name, maintains the records for the Service and tabulates and summarizes the reports received from the provincial offices.

An important staff officer in the Service, although his position is nominally a temporary one, is the representative of the Government Agricultural Development Plan. While this officer does not head a division, he is the liaison officer between the Service and the Planning Section of the Ministry for the execution of the Special Welfare Plan of the Government. This plan was originally conceived as a three year plan and is being extended one year at a time as its objectives are unattained and further objectives are established. As a program established for emergency rehabilitation of the country, the Welfare Plan has an independent budget, from which the various ministries and services may receive funds, in addition to their normal budget, for special projects which are considered abnormal to the functions.

FARMERS' RUBBER SERVICE. The Farmers' Rubber Service, like the Farmers' Agricultural Service, does not include extension in its name, Djawatan Karet Rakjat, but one of the functions of the Service is that of a rubber extension service for the rubber producers. The organization of this Service is similar to that of the Farmers' Agricultural Service with the exception that there are many areas in which there are no plantings of rubber by farmers and the Rubber Service has no representatives in these areas. The Service is concerned with the dissemination of information on rubber production and processing to enable the farmer to produce the highest quality rubber possible with the limited facilities usually available and through the development of cooperatives to increase the quantity and quality of processing installations in order to further improve the quality of rubber produced. The Farmers' Rubber Service, just as the Farmers' Agricultural Service, has found that the farmers are unable to purchase the commodities needed through commercial trade channels and has therefore been forced to become a distribution agency for the staple commodities of the trade which include alum and formic acid as coagulants, coagulation pans, and rubber mangles (rollers), with which the coagulated latex can be pressed into sheet rubber to be either air dried or dried in smoke houses. The need for smoke houses has compelled the Service to include corrugated galvanized iron in its supply of commodities for sale to the farmers.

Because a higher proportion of farmers with rubber often live in relatively remote, and sparsely populated areas, the lack of transportation is a far more serious problem for this Service to overcome than for the Agricultural Service. In some areas of Sumatra and in most of Kalimantan where there are rubber producers, the only transportation is by small boats, usually dug-out canoes; however, recently outboard motors have been used in larger quantities because of the favorable world prices for rubber in 1950-51. The effectiveness of the work of the Service in the vicinity of Sibolga on Sumatra's west cost is

reflected in the closing of two Chinese owned rubber remilling plants in 1952. These plants formerly were able to buy sufficient slab rubber, the lowest grade and the only grade that the farmers could produce without equipment, and remill it to produce blanket rubber for export. The price spread between these different qualities of rubber is sufficient that such a plant can operate profitably if the supply of slab rubber is adequate to permit the plant to operate near capacity. As the farmers were able to obtain coagulants, coagulating pans, and rubber mangles from the Service and through normal trade channels, they began making sheet rubber in lieu of slab rubber. Although it was still necessary for most of the sheet rubber to be air dried, some was smoked, but with the decrease in the availability of slab rubber the remilling plants were no longer able to operate profitably because the sheet rubber can be exported without further processing and the price spread between the sheet and the remilled rubber would not enable profitable operation of the plants.

SEA FISHERIES SERVICE. The name of the Sea Fisheries Service is indicative of its function but not the broad scope of its activities. The dual objective of the Service is to enable Indonesian fishermen to provide more fish to offset the general food deficit of the country and more specifically to offset the deficiency of animal protein in

the average Indonesian diet. It is expected that by 1960 the per capita annual consumption of fish will climb from the present estimate of eight pounds to twenty pounds or more because of the increased availability from the work of the Sea Fisheries and the Inland Fisheries Services.

The Fishing Technology Division of the Service is responsible for the dissemination of knowledge of improved fishing gear and techniques to the sea fishing industry. The Biological Division is compiling information about the various fishing waters and conducting fishing on an experimental basis in undeveloped areas. This information will include data on species of fish in the various areas and other basic data necessary for the improvement and expansion of the industry in the vast seas of the Archipelago.

The Fishing Vessel Design Division operates a number of boat yards for building vessels adapted to Indonesian conditions and fishing techniques and also for the maintenance of the fishing fleet. The activities of this Division include the construction of motorized vessels able to operate in larger areas with greater efficiency than the native sailing praos, which while colorful do not enable the production of fish the waters are capable of supporting.

The Sea Fisheries Foundation in the domestic industry is assisting in the formation of fishing cooperatives and the operation of auction sheds to enable fishing crews to purchase and operate motorized vessels, to receive a greater share of the profits of their work, and to enable the efficient sale and prompt disposal of the fish. In the international arena this Foundation is responsible for the preparation of international agreements pertaining to fishing and representatives of the Foundation are present at the negotiations of such agreements. The auction sheds operated by the Foundation or under its sponsorship are self-supporting; a percentage of the receipts of all sales is retained to cover the overhead and other costs incidental to the business.

Supporting operations of the Service include the distribution and sale of supplies, the construction of ice plants, and the operation of carrier vessels. The first of these supporting operations has been in effect for many years, but the ice plants and the carrier vessels have not yet passed the planning stage.

ANIMAL INDUSTRY SERVICE. Although the literal translation of Djawatan Kehawanan is Livestock Service, the references to this Service in English are usually to the Veterinary Service for many of the officials of the Service are veterinarians. The objective of the Service is to improve and to increase the amount of livestock available in Indonesia, both for draft animals and for food. In the accomplishment of these broad objectives the Service has a general livestock extension program, an animal breeding program, and a quarantine program.

The general livestock extension program furnishes information to farmers relative to proper management of livestock and includes investigation of animal diseases and their treatment. The latter is especially true when diseases have the prospect of becoming epidemic in proportions.

The Service also is operating a livestock loan program on the island of Sumba which, because of its unique character, deserves brief description. This loan program is exceptional in that cattle and goats are loaned to farmers who have not previously owned livestock and under the terms of the written loan contract are repaid in kind after a period of two to five years. At the inception of the program, which is handling only cattle and goats, a unit of livestock consisted of one male and ten female animals which were loaned to the farmer to care for under the supervision of the _mantris_ of the Service. The farmer who obtained the livestock agreed to repay the livestock within a period of five years in one year old animals to be selected from his herd by the officials of the Service. In addition to the number borrowed, the farmer must also pay three animals as interest and prior to the full repayment of the loan cannot kill or sell any animals without consent of the Service.

This restriction not only encourages farmers to repay the loan as quickly as possible but also permits the Service to effectively carry out an improvement program by giving permission for the farmers to kill or sell the least desirable animals. In November 1952, the Chief of the Service on Sumba stated that there were 175 such loan contracts in effect but that under new contracts a livestock unit is only five females and one male with a three years' time limitation for the loan to be repaid with only one additional head required for interest.

In addition to the above program on Sumba, the Service is cooperating with the Farmers' Agricultural Service to furnish livestock for a _mantri_ course. In the course the men are learning to use the cattle as draft animals with plows and harrows and at the same time are training the cattle. When a _mantri_ is later assigned to work in a village, the cattle will also be sent to the village to enable the _mantri_ to conduct demonstrations in this relatively advanced technique.

The Veterinary Service also operates quarantine stations at the various ports where the export or import of livestock is important. Livestock must remain in quarantine for two weeks prior to export, and during this period they are inspected by the veterinarians and receive any innoculations necessary. If the livestock are held in the pens of the Service, feed must be furnished by the owner, but routine attention is by employees of the Service.

The livestock and poultry improvement program of the Service is spread throughout most of the Archipelago but is still in the initial stages of implementation in most areas. The establishment of poultry hatcheries seems to have made the greatest progress, and at the breeding centers there are small flocks of various red and white breeds, as well as the Austrolorps. In the future the best adapted of these breeds will be crossed with local breeds for a general improvement of both egg and meat production.

In West Central Sumatra there is considerable interest in the introduction of Arabian blood lines to increase the size of the local horses. This program was started prior to the war and is again receiving much attention, and there are now a total of twelve Arabians at the breeding center east of Bukit Tinggi. Five of these twelve, three stallions and two mares, were imported in 1952 while the remainder are the best locally available horses with some Arabian blood. Mares raised at this station will be kept for further breeding, but the stallions will be placed in the villages of the area for periods of three to five years, after which they will be moved to other villages to avoid too much inbreeding.

At its various establishments the Service also is conducting experimental plantings of various pasture grasses. There are no improved pastures in Indonesia, and before livestock production can attain its proper relationship in the agricultural development of the sparsely populated areas of the Outer Islands, information must be available to permit the production and perhaps the conservation of adequate supplies of feed. At the present time the amount of native grass available during the dry season is a controlling factor in the production possible.

FOREST SERVICE. The Forestry Service is responsible for the management and exploitation of the Government owned forest lands which include not only the planted teak forests of Java but also many areas of virgin forests on the other islands. The reforestation of denuded areas where erosion has become a serious problem, especially on Java where the remaining forest cover[1] on 23 percent of the island's area is considered to be the absolute minimum to maintain a balance of the hydrologic cycle, is of major importance in the considerations of the Service. Although exploitation of some of the forests of the Outer Islands is in the advanced planning stage, the principal activity of the Service in these areas has been the attempt to control the promiscuous destruction of forests by the ladang culture of the farmers.

To carry out its functions the Service has the following divisions: Planning, Commerce and Industry, Technical Affairs, Information and Education, and the Institute for Forestry Research. The last named division not only is concerned with production but also is conducting research

1. Metcalf, op. cit., p. 14.

studies in the utilization of forest products.

AGRICULTURAL ESTATES SERVICE. The primary function of this service is to represent the Government in the field of large scale agricultural enterprises producing commodities for the export. This Service must maintain accurate records concerning all phases of estate agricultural enterprises and must enforce the regulations of the Government pertaining to their operations. In order to perform its functions, the Service must know the ownership of the enterprises, the status of world markets for the various products, and the current levels of production of the estates and also of farmers producing competitive commodities.

As a result of the direct damage from the war and the "police actions", the lack of routine maintenance, the lack of replacement of machinery or parts of machines, and the removal of machinery or the conversion of plants by the Japanese, both field machinery and processing equipment of the estates were in poor condition when the present Government came into being. One of the functions of the Estates Service is to assist the estates in obtaining the foreign exchange necessary for the import of essential supplies for rehabilitation and routine operation. The Service also has the responsibility for seeing that the foreign exchange thus obtained is expended in according to regulations. Also included in the responsibilities in the financial field is that of furnishing the Minister of Finance with data necessary for the establishment of rates for export duties on estate crops.

Although the above functions of the Service are partially of an emergency nature and others are normal, recurrent functions, the greatest problem perhaps is to return foreign owned estates to their owners and with other agencies of the Government to arrive at a policy for the renewal of leases as they expire. As previously stated, the Agrarian Law of 1870 provided that the normal lease for estates would be seventy-five years which, of course, means that the earliest leases have recently expired and that many others will expire in the next few years. At the present time the managements of the estates are in such a position that they risk any additional investment if the remaining time of the lease is insufficient to permit amortization; however, in many cases, if additional investment is not risked, the efficiency of operation will decrease so that the estates cannot operate profitably. Related to this same problem in several areas is the clamor of the people for the land of the estates and in others actual occupancy of the land by indigenous people. Until a definite policy can be established and effectively administered, this will continue to be one of the most difficult problems of this Service as well as that of several other agencies.

The Estates Service is also charged with the responsibility of establishing prices to be paid by the estate processing plants for the raw products of farmers, especially tea and quinine. In this problem the Service must try to obtain agreement between the farmers and the estates that will allow the estate a fair margin of profit for the services performed but at the same time will give the producer a fair price for the raw material.

The final responsibility of the Service is of a catch-all nature in that they are authorized to undertake research pertaining to cultural techniques, to processing techniques, and to the marketing of export commodities especially as these may enhance the export position of the indigenous producer.

AGRICULTURAL RESEARCH AGENCIES. The Agricultural Research Agencies are responsible for the conduct of fundamental, and applied research with particular reference to those areas of applied research which are beneficial to indigenous agriculture. The functions of this Service are carried out through the Central Agricultural Experiment Station at Bogor and through its various branches in other parts of Indonesia. The development of new varieties of crops adapted to indigenous agriculture, especially rice and corn, determining fertilizer requirements of various crops under different conditions of soils and climate, and

the relationship of fresh-water fish production to rice production with irrigation waters under definite rotation plans are illustrative of the scope of work undertaken by this Service. The systematic survey of the soils of areas under consideration for particular projects, as well as the routine analyses of soils to add to the basic knowledge of the soil resources of the country, is the responsibility of one division of the Central Agricultural Experiment Station, and the technique of controlling plant diseases and insects is the responsibility of another division.

NATURAL SCIENCE RESEARCH SERVICE. While the principal function of the Natural Science Research Service is to conduct fundamental research in tropical botany with special attention to plants of importance to Indonesia either as ornamentals or for their possible economic importance, its secondary responsibility, for which it is better known, is the maintenance of the world famous botanical gardens in Bogor. As previously described Kebun Raya Indonesia or Buitenzorg Botanical Gardens as they were formerly known, occupy an area of more than six hundred acres in Bogor and have one of the largest varieties of tropical flora adapted to low altitudes of any botanical garden in the world. It is through these gardens that oil palm, quinine, and rubber have been introduced to Indonesia from their native habitats of West Africa, Honduras, and Brazil.

INSTITUTES. The semi-autonomous institutes for General Livestock, Livestock Diseases Research, and Inland Fishery Research conduct research in their respective fields as indicated by their names and work in close coordination with the Central Agricultural Experiment Station and the respective Services concerned with applications of research in the same respective fields.

FOUNDATIONS. The Food Supply Foundation is responsible for the administration of the Government program of food supply and distribution. This agency issues regulations which are necessary for the execution of the program and controls the import or export of food, the purchase of food supplies from surplus producing areas within Indonesia, and the distribution and sale of foods to the deficiency areas. Under these provisions regulations limiting the amount of rice that can be milled or can be held by an individual or company without license are promulgated to prevent hoarding for sale at times of short supply. The method of price control is to release rice from Government owned stocks for sale at fixed prices whenever local upward price trends become apparent. This Foundation was originally in the Ministry of Agriculture and maintains close liaison with the Ministry of Agriculture, although it is now in the Ministry of Economic Affairs.

The Copra Foundation is an autonomous semi-private, semi-Government agency which is the sole exporting agency for copra and which was established to stabilize price fluctuations and at the same time to guarantee prices which would enable production at a profit. Representatives of both the Ministry of Agriculture and of the Ministry of Economic Affairs are on the Board of Directors of the Foundation.

The Clove Foundation was established in 1952 in a similar manner to the Copra Foundation for the purpose of regulating the price and supply of cloves available to the kretek cigarette industry of Indonesia. Because the regular supply of cloves for the industry affects such a large group of laborers, the continuous operation of the industry is of major importance to the economy of the people in the areas adjacent to the cigarette factories. The Government is also concerned with the maintenance of a stable market for the cloves because of its influence on the economy of the Moluccas, the major clove producing area.

The Foundation for Indonesian Agricultural Estates was established for the specific purpose of operating the agricultural estates formerly owned by the Susuhunan and the Mangkunegaran Governments of Central Java. Prior to World War II these two governments were the semi-autonomous princedoms of the two royal families which ruled according to ancient customs and rights and with little, if any, interference from the Netherlands Indies Government. After the war these properties became the property of the new Government, and the Foundation was established for the management of the enterprises which included sugar mills and rubber processing plants amont others. While the enterprises will be conducted with full consideration for their commercial value, it is also intended that they will develop a sound pattern of cooperation between capital, labor, and management and also a basis of cooperation between estate type enterprises and the farmers in the vicinity of the estates -- a yardstick, so to speak -- for the many privately owned estates. At the end of 1952 the Foundation had progressed little beyond the planning stage, and information is not available as to the exact method of operation that is being followed.

For the coordination of the services rendered to all phases of agriculture through the various agencies of the Ministry of Agriculture, there are three general groups. The Chief of the Farmers' Agricultural Service is charged with the responsibility of coordinating the activities of the Farmers' Agricultural Service, the Agricultural Research Agencies, Agricultural Education, Farmers' Rubber Service, and the Inland Fisheries Service. The Chief of the Estates Service is charged with the responsibility of coordination of the Agricultural Estates Service, the Government Agricultural Estates, the Agricultural Estates controlled by the Republic of Indonesia, and the Indonesian Native Agricultural

Estates Foundation. The Chief of the Animal Industry Service is charged with the responsibility of coordinating the activities of the Animal Industry Service, the Institute for General Livestock, and the Institute for Livestock Disease Research.

CHAPTER XII

IRRIGATION AND EROSION CONTROL

A. Irrigation

The development of irrigation is the same study in contrasts that is found in all other phases of Indonesian agriculture. There are the primitive irrigation systems developed by the farmers, as individuals or through community effort, systems which have been developed and extended by successive generations without benefit of engineering design or survey. There are also the technical irrigation systems designed by the irrigation engineers of the Netherlands Indies Government, systems which have been designed with due consideration given to the hydrologic and structural details, as well as to the economic feasibility of such systems.

Occasionally one sees, in articles about Indonesia and other Far Eastern countries, statements that the primitive irrigation systems and the bench terraces that have been constructed by successive generations of farmers are so perfect that engineers with transits could not improve the layout and design of these systems. From the standpoint of scenic beauty such statements are correct; it makes no difference in the appearance of an irrigation channel whether its grade is 0.1 or 3.0 percent, but from the

standpoint of diverting water from a stream to the highest possible elevation on the side of a hill, the difference is of basic importance. While water is satisfactory as a measuring gauge for leveling the area between terraces, especially those terraces with very small areas, almost invariably upon close inspection the supply channels appear to have steeper grades than are essential. If these channels were surveyed with minimum grades, water would be discharged at higher elevations, and the irrigated fields could extend further up the hill or mountain sides; however, in some instances such surveys would be of no value because the available water is insufficient for more land than is already irrigated.

The Indonesian Government has continued the general concept of the Netherlands Indies Government's basic policy in regard to irrigation, a concept which in principle is not conducive to maximum efficiency of irrigation because there is no direct charge for water used. Under this condition the Indonesian farmer, when possible, uses more water than is necessary for his rice fields just as the Louisiana rice farmer who pays 20 percent of his production to the pumping company for water uses more than is necessary for his rice fields. There is more justification for the Indonesian farmer who receives water from streams originating in volcanic ash, water which has been shown by chemical analyses to have enough plant nutrients to have beneficial effects on the yield, than there is on the part of the Louisiana farmer whose only concern for the chemical content of the water is that it does not carry a high enough salt content to be toxic to the rice. This inherent weakness in the irrigation policy is minimized by the mantris of the Irrigation Division of the Ministry of Public Works and Power, who actually supervise the final distribution of the water from the technical systems.

The irrigation policy has given the Irrigation Division of the Ministry the responsibility for the design, survey, and construction of the diversion structures, the primary and the secondary channels, and all regulating and distribution structure to the tertiary or field distribution channels. The tertiary channels are designed and surveyed by the Irrigation Division, but the actual construction is the responsibility of the village and is performed cooperatively by the farmers, usually under the supervision of the irrigation mantris. The field supply ditches are constructed and maintained by the individual farmers, and the responsibility of the tertiary channel maintenance is the village responsibility; similarly, the Irrigation Division maintains that part of the irrigation system constructed by it.

The policy of the Netherlands Indies Government was to make an economic survey for each proposed irrigation system;

if through the increased land rents or taxes payable to the Government the construction costs of a project could be amortized in a reasonable length of time, approval for the initiation of the project was given. The income from the project was based upon the rental charges which were on a sliding scale with irrigated rice lands at the top of the scale and tegalans at the bottom of the scale.

The greatest difficulty of the Indonesian Government in the continuation of the policy as stated above is the shortage of personnel with engineering training to plan, design, survey, and supervise the construction of irrigation projects. In some areas the general security situation has delayed available personnel from performing their duties effectively, and several large projects initiated prior to the war remain incomplete. Illustrative of the difficulties confronting the provincial officials are the conditions in the provinces of South Sumatra and Sulawesi in 1951 and 1952 at the time of short visits to these areas by the author.

In the provincial office of the Ministry of Public Works and Power in South Sumatra there were two graduate engineers; one was the Provincial Engineer, while the second was his assistant in charge of construction and maintenance of public buildings. The assistant engineer for irrigation was a young man who had finished the technical high school, approximately equivalent to junior college in America, and who had had about five years' practical experience in

irrigation work. In this province the principal irrigation projects prior to the war were those in the colonization project areas.

In the Belitang project area the diversion structure on the Komering River (Figure 62) has a design capacity of approximately 1300 cubic feet per second during the normal river stages of the wet monsoon from November until May. The main diversion canal is approximately 15 feet deep with a bottom width of 15 feet and a top width of about 40 feet and is five miles in length from the river to the project area. The primary canal and the control structures for the secondary channels were completed prior to the war, but only enough secondary canals were completed to permit the irrigation of 10,000 acres or about 10 percent of the potential of the system. The primary canal, for lack of maintenance from 1941-50, was in poor condition because of bank caving, silting, and the growth of weeds in the channel, conditions indicative of the need for considerable work to enable the extension and the efficient utilization of the system.

Another irrigation project of comparable size to the Belitang area is near Metro, where the Argoguruh Dam (Figure 63) on the Sekampong River also has a design capacity of about 1300 cubit feet per second and diverts water through the ten mile primary channel to the main control structure where some of the water could be delivered to the secondary canals for distribution to the fields and excess water could

Figure 62. Control structure on Belitang irrigation project in South Sumatra

Figure 63. Argoguruh Dam on Sekampong River in South Sumatra

be diverted to the Batanghari River. It was stated by irrigation officials that eventually the capacity of the Argoguruh Dam would be increased by raising the crest of the weir so that another irrigation project twenty miles downstream on the Batanghari River could be established in the Roemi area. In contrast to the free inlet structure on the Komering River, the Argoguruh Dam is a diversion dam and can be used throughout the year. The total area of irrigated fields in South Sumatra in 1951 was given as 65,000 acres with an additional 115,000 acres under the lebak culture.

In the province of Sulawesi there are two graduate engineers in the provincial services of the Ministry of Public Works and Power, one in the capitol at Macassar and the second in North Sulawesi. Here as in the other provinces the Public Works engineers are assisted by practical engineers, men of elementary or perhaps high school education who have learned the basic elements of engineering by working under the supervision of the Dutch engineers of pre-war days. While there have been many good engineers throughout the world who have never attended college, it must be remembered that under the Dutch professional personnel, little effort was made to train Indonesian personnel except for routine work and even then only the techniques were taught, not the basic principles which would give personnel an understanding of the reasons for a technique.

The difficulties of extending the irrigation systems of

Sulawesi have been magnified to a considerable degree by the conditions of security, especially in the vicinity of the Sadang project east of Pare-Pare in the southwestern leg of the island. This project was designed and initiated prior to the war and will have, when completed, an area of about 150,000 acres under irrigation. During the unsettled years all of the basic data and surveys for the completion of this project were lost or destroyed. The lack of engineers makes it very difficult to make the additional field surveys necessary to obtain the data for redesigning the system, but even if there were engineers available, it would only be under the laissez-faire between the Army and the dissident forces that would enable such a survey to be made. The farmers of the area are said to have made some temporary repairs for parts of the project and to have done some work on the extension of the channels without benefit of surveys, but the complete details of the project appear rather vague, a condition that can be remedied only by the presence of more engineers and less fighting between the Army and the guerillas.

The provinces of South Sumatra and Sulawesi have been cited only to illustrate the dearth of well qualified personnel; other provinces are in little better position, if any better. These remarks should not be interpreted as being derogatory towards the personnel of the Irrigation Service. The scope of existing irrigation systems is so great that even a minimum degree of supervision of the operation and maintenance of these systems is physically impossible because of the limited personnel and the difficulties of travel and communication. Perhaps the outstanding example of an official having too many assignments is the chief engineer of the Irrigation Service who, in addition to this primary responsibility, is a special lecturer in irrigation, teaching courses in irrigation engineering at university level in three institutions in three cities besides Djakarta where the central irrigation office is located. The personnel situation is disheartening when the few engineers graduating are attracted to private employment by salaries two to three times more than those allowed by the Government for single men; there is less difference in the case of married men because of family allowances.

In areas where primitive irrigation systems have been constructed by the villages or by individuals there have sometimes been contributions of materials or design and layout by the Government either through the Division of Irrigation or through the Farmers' Agricultural Service. Because the Ministry of Public Works and Power has been so overtaxed with the necessity of repairing roads and bridges, of constructing new buildings, and of repairing and constructing power plants and power distribution systems, the Farmers' Agricultural Service has played a far greater role in the repair, maintenance, and construction of primitive irrigation works than in former years.

In the technical irrigation systems the distribution of water has been regulated in accordance with the design of the systems and according to very exact schedules based upon the quantity of water available, especially in areas of limited supply. Under the primitive systems the right of prior claim is followed, and as probably is common throughout the world, arguments over the use of water are sometimes very bitter. Under the communal control of Bali one of the grounds for a farmer to be banned from his village is the use of more water than he is entitled to at the expense of some other member of the village. Figure 64 shows the result of an argument over water from an irrigation canal in North Central Sumatra. The irrigation canals shown leading around the mountainside were said to be 4.5 miles in length. The upper channel was constructed by two brothers who later had an argument either about the quantities to which they were entitled or as to which one should have the water at a certain time. The argument became so embittered that one of the brothers dug the lower canal for his exclusive use and did not speak to his brother again during their lifetime.

Because vitually all of the irrigation systems are dependent upon diversion from streams and are without

Figure 64. Mountainside irrigation ditches in North Sumatra

Figure 65. Bucket on bamboo pole for irrigation from open pit in East Java

reservoirs, the amount of water available is dependent upon the stream flow. Because the watersheds are relatively small, the water supply is quickly and materially affected by variations in the rainfall. The Bengawen Solo River in East Central Java has the largest watershed of any river on the island (5970 sq. mi.[1]). Irrigation systems are designed upon the basis of hydrologic data collected by the Meteorological and Geophysical Service of the Government which also predicts the beginning of the wet monsoon each year. The area irrigated from a particular structure is sub-divided, and water is furnished to the sub-divisions for nursery beds, for land preparation, and for growing rice according to rigid schedules in order that maximum efficiency of irrigation may be obtained. The order in which the sub-divisions receive their first irrigation water each year also follows a definite schedule. Many of the systems do not provide sufficient water for irrigation of all areas in rice during the dry monsoon; some are for the wet monsoon only. Where there is some water during the dry monsoon, its distribution follows the same general pattern with the sub-district having advance notice that there will be enough water for a given proportion of irrigated and dry crops for the season provided normal rainfall occurs.

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1. J. H. De Haan, Adequate Water and Land Use, <u>O.S.R. News</u>, Bureau of Land Utilization, Oct. 1950, Djakarta, pp. 2-10.

In the mountainous areas of Java where there is adequate rainfall for irrigation of most of the rice fields throughout the year, the same maximum efficiency in the use of water is obtained by the successive distribution of water to sub-districts to meet their maximum requirements for land preparation and at the time of transplanting, after which the requirement drops during the growing season so that the quantity of water for that sub-district may be reduced and more water given to another. This system of water rotation results in another landscape picture that is difficult for one accustomed to the temperate climates with definite seasons where all fields of one crop are at approximately the same stage of maturity. For example, within an area of no more than one or two acres one may see the greenish yellow carpet of rice in nurseries awaiting transplanting, one area being plowed and harrowed in preparation for planting, another small area with rice just past the yellowish stage that follows transplanting, another terrace knee high and in bloom, and still another with the rice turned to the greenish gold of maturity indicating the time for sharpening of the ani-ani knives for the harvest.

The best available estimate of areas of the total extent of irrigated lands in Indonesia is shown in Table VI. In this table no differentiation is made between the lands irrigated by technical irrigation and primitive irrigation

TABLE VI

EXTENT OF IRRIGATION IN INDONESIA

Area[1]	Already irrigated		Under construction (complete in 1955)	Additional proposed construction
	1938	1950		
Java and Madura	8,225	8,360	2.5	64.3
Sumatra	550	585	19.8	722.0
Kalimantan	334	370	58.3	334.0
Sulawesi	704	715	32.1	385.5
Lesser Sunda Islands	600	625	2.5	108.0
Moluccas	--	--	--	--
Totals	10,413	10,655	115.2	1,613.8

systems or those areas dependent upon rainfall. While a more accurate breakdown would be desirable, it is almost, if not completely, impossible for the Irrigation Division to obtain complete, accurate reports from the provincial officials just as is the case with some of the services in the Ministry of Agriculture, a condition which is the result of two principle factors. The major factor probably is the lack of qualified personnel in the provincial offices of the various services, but the semi-independence of the provincial services from the ministries is also a contributing factor. The officials of the provincial services, while technically responsible to the various ministries, are administratively responsible to the provincial governors and to the provincial councils; therefore, there is the tendency to render promptly reports which will be of immediate benefit to the provincial services and the parallel tendency of delaying reports which might be unfavorable to the provinces.

During 1940 and 1950-52 the average yield of irrigated rice on Java and Madura was 0.97 short tons per acre and on the other island 0.89 short tons per acre, while the yield of padi gogo or dry rice was 0.45 short tons[1]. These yields are in terms of padi and are approximately twice the equivalent value of head rice. The difference in the yields

1. Soetijo, op. cit., p. 343.

of irrigated and non-irrigated rice is indicative of the importance of extending the area under irrigation as soon as possible as a part of the Government program of adequate domestic food production. In Table VI is also shown the additional area to be irrigated by the end of 1955 for the projects now under construction and the area of additional projects under consideration but on which construction has not yet been initiated.

The use of reservoirs to store water from the wet monsoon rains to use for irrigation during the dry monsoon or their value to assure ample water at the end of the wet monsoon have never been common in Indonesia, nor were dual purpose power and irrigation projects undertaken before the war. The total capacity of the reservoirs constructed by the Netherlands Indies Government (Table VII) was sufficient for the irrigation of no more than about 50,000 to 60,000 acres, less than 1 percent of the irrigated area of Java and Madura. Farmers have used waduks or small reservoirs to a limited degree in East Java, but elsewhere in the Archipelago they are seldom seen. The combination of climate and topography accounts for the absence of reservoirs for irrigation and the absence of industrial development, together with the inability of the greatest percentage of the indigenous population to afford electricity in their homes, minimized the demand for hydro-electric development.

TABLE VII

IRRIGATION RESERVOIRS ON JAVA

No.	Name	Storage capacity in acre feet	Height of dam in feet	Year of completion
		Irrigation Only		
1.	Pridjetan	7,299	58.0	1917
2.	Patjal	32,440	114.8	1933
3.	Gembong	8,110	124.6	1933
4.	Gunung Rowo	4,055	65.6	1926
5.	Pendjalin	7.705	72.2	1934
6.	Melahaju	48.660	82.0	1940
7.	Satu Patok	11,354	88.6	1926
8.	Darma	32,440	75.4	under construction
9.	Tjipanas	64,880	131.2	do
10.	Tjatjaban	64,880	98.4	do
		Irrigation and Power		
11.	Tarum	892,100	311.6	do
12.	Djati Luhur	2,433,000	262.4	do
13.	Pohadji	1,865,000	?	?

Areas shown are in thousands of acres. Source: Informal report, Kementerian Perkerdjaan Umum dan Tenaga, Bagian Irrigasi, April 1953.

The topography is such that generally the cost of construction of dams would be high in proportion to the storage capacity of reservoirs; in the mountainous areas near the stream headwaters reservoirs would have relatively small capacity in proportion to the height of dam necessary, and at the lower elevations direct flood damage or rapid decrease in capacity because of sedimentation would tend to make the cost of the effective capacity of the reservoirs uneconomical.

Primitive lifting devices found in some other Eastern countries have not been developed in Indonesia; however, buckets on ropes swung by two men standing about ten feet apart are sometimes used to dip water from channels into adjacent nursery beds. In East Java five gallon cans are hung from the end of long levers (Figure 65) to enable the farmers to dip water from shallow open pits. The open pits, from five to eight feet in depth, generally rectangular in shape, and with top dimensions of eight by fifteen feet or more, are temporary as they are dug for the irrigation of supplementary food crops during the dry monsoon; after the corn or other crop has matured, the pits are refilled in preparation for rice planting on the rain dependent <u>sawah</u> in the wet monsoon. The pits are dug to a depth necessary to obtain about two feet of water, and by dipping the pit dry twice, daily the farmer is able to irrigate from 0.25 to 0.50 acre from each pit. East Java

officials estimated that in 1952 there were 3000 such pits or wells in the vicinity of Ngandoek and Patje in the Kediri Kabupatan in a total area of 250,000 acres without permanent irrigation facilities. When asked why a few good permanent wells were not developed and equipped with pumps to operate through farmers' cooperatives and to be paid for by the farmers, the officials answered that the farmers could not afford the cost of operation of the pumps. In this answer is the attitude of many Indonesians towards the value of farm labor and also towards the installation of pumps for irrigation because of the recurrent operating expenses that are envisioned.

In contrast to the above picture is the initiative of the Irrigation Division of the Ministry of Public Works and Power for East Java which in 1952 salvaged a 14-inch centrifugal pump from one of the destroyed sugar mills and installed it on the Bengawan Solo River near Tuban in the Surabaja Kabupatan. The capacity of this pump, 66 gallons per second against an elevation head of 13 feet, was sufficient to provide water for 3075 acres of secondary food crops and rice nurseries in the dry monsoon of 1952 at an operating cost of $175.00 per month or approximately $875.00 for the growing season. Installation of a second pump with capacity of 53 gallons per second was not completed in the 1952 dry monsoon because of a lack of parts that were being made in Surabaja, but more than 5000 acres will be

irrigated from these pumps in the dry monsoon of 1953. The pumping plant (Figure 66) was constructed behind the flood control levee of the river with a system of gates leading from the river to the supply channel that would enable irrigation by gravity flow when the river reaches flood stage during the wet monsoon. The above costs are for the actual operating expenses of the plant only; the irrigation official who supplied the data was unable to give the total cost of the installation or the cost of its amortization.

Because the pre-war use of irrigation pumps was restricted almost entirely to the estates where they were kept in reserve for use when water from the normal diversion systems was insufficient, cost data are unavailable for planning purposes. After the 1953 dry season limited data from various areas will be available from the pumps installed in 1952 and 1953. In 1951 the Economic Cooperation Administration authorized the purchase of 20 portable 1.5-horsepower pumps to be used at the various farms operated by the Farmers' Agricultural Service; the purchase of twenty 10-horsepower pumps and ten 15-horsepower pumps was also authorized for field installation. These pumps were to be installed in the provinces for demonstrations in order to determine the feasibility of irrigation by pumping. In 1952 the Ministry of Agriculture purchased an additional fifty of the 15-horsepower pumps to extend the installations

Figure 66. Pumping plant on Bengawan Solo River in East Java

Figure 67. Water ponded above terraces of Central Java erosion control demonstration

over an even larger area. Numerous difficulties including lack of pipe, valves, and fittings in the provinces, insufficient money in the 1952 budget for the purchase of these accessories, transfer of the responsibility for installation from the Farmers' Agricultural Service to the Irrigation Division, and the lack of qualified personnel to supervise the installation of the pumps prevented the completion of installations before the beginning of the wet monsoon when they were not particularly needed.

It is probable that pumps will have their greatest value in the field of supplemental irrigation for food crops other than rice during the dry monsoon. In addition to the rainfall, estimates of the water requirements for irrigated rice vary from 1.5 acre feet to about 4.0 acre feet per acre during the four to five months' growing season. The wide variations are influenced by the porosity of the soils and also by the variation in rainfall of different locations, but because of the cost of purchasing, installing, and operating pumps or any other type of machinery in Indonesia, efforts to pump water for rice should be undertaken on an experimental basis only. Although specific data are unavailable as to the cost of operation of pumps, high costs are anticipated because the high initial costs of the pumps, pipe, valves, and fittings, almost all of which must be imported. Similarly actual

operation and maintenance costs will be high; inexperienced personnel will cause unanticipated damage, replacement parts must also be imported, and often mechanics for the repair of motors must be sent from the larger cities.

Irrigation experience under the varied conditions of the country has led the Irrigation Service to adopt, as a basis for preliminary planning, a water requirement of one liter per second per bauw (0.7 hectare or 1.73 acres) or the equivalent depth of 0.48 inch per day for irrigated rice. In the planning of new projects this figure is used, but it is refined as investigations yield further data about the specific soil conditions and water requirements within the project area. The actual requirements of water for irrigated rice vary between the limits of 0.17 and 0.85 inches per day over the irrigated area.

B. Erosion Control

Between 1845 and 1930 the population of Java and Madura increased from an estimated 4.5 million to almost 41 million inhabitants[1]. Estimates of the population increased in the Outer Provinces during the same period of time, but as shown in Table I the population density is relatively low even today. At the time when the land requirements of the people for food production were low, erosion control was of little consequence; the _ladang_ culture, which permits land

1. Robert Payne, _The Revolt in Asia_, John Day, New York, 1947, p. 15.

to return to natural vegetation after two or three years of cultivation and to remain under the heavy vegetation for seven to ten years or even longer before again being cultivated, permitted the replenishment of the organic content of the soil and minimized erosion. The ladang culture, when population demands permit the natural vegetation to remain a long time, also minimizes the erosion damage because the fields cultivated are small; there are few long, continuous slopes in clean cultivated crops to cause increasing damage at the lower elevations.

The increase in population has increased the area required for cultivation in food crops, and this in turn has decreased the time tha land can remain under natural vegetation. The increase in land required has also caused the farmers to cultivate less desirable land; as the yields from the gently sloping areas decreased, the steeper, more erodible slopes were brought into cultivation and erosion occurred at increasing rates. The increased areas under cultivation not only decreased the time the land was protected by vegetation but through increased fire damage to the vegetation decreased its effectiveness. The early recognition of the importance of forest resources in relation to the protection of soil, to the preservation of the forests, and to the benefit of water resources is shown in the establishment of forest reserves in 1865 and the

promulgation of the Reclamation Ordinance in 1874[1]. Even with the law its provisions were not closely observed and the extent of erosion increased.

Throughout the Archipelago wherever it has been possible to construct diversion structures for the irrigation of rice, erosion control has been the secondary result of the construction of bench type terraces with the areas between the terraces leveled to enable even distribution of water. Each terrace is a retention basin from which the excess rainfall passes to successive terrace areas below through the drop outlets prepared by the farmer. The drop outlets are usually gaps in the terrace ridge, but the soil lining of each gap has been puddled and packed to make it erosion resisting; however, the water often passes from one terrace to the next lower one through large bamboo tubes and spills on a stone to disperse the hydraulic force. When terrace banks are too steep and have excessive height, small landslides or mud flows occur as a result of the soil becoming saturated.

Erosion is more serious in the areas of dry farming than under conditions which exist with irrigation. The greatest damage affecting large areas has occurred on the Tertiary marly clay soils of Central and East Java and on

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1. J. H. De Haan, The Economic and Social Aspect of Erosion Control, Paper, ECAFE Flood Control Congress, New Delhi, Jan. 1951, p. 2.

the marl and limestone soils of Madura. It is only in these areas that one sees fields reminiscent of the eroded red hills of the Piedmont Region in the southeastern part of the United States. The shallow topsoils of these areas are underlain by almost impervious marl or other calcareous subsoils so that the runoff from the intense rainfall of the wet monsoon is extremely high because the moisture content of the soil remains near the moisture holding capacity throughout the rainy season. Other areas where considerable erosion damage has occurred are South Sumatra, South Sulawesi, Sumba, and Flores.

In all areas of Indonesia erosion is occurring at a rate which is the cause of concern, a rate which is most clearly indicated by the condition of the silt-laden streams. Several rivers in East Java are now flowing in channels higher than the land on either side of the rivers as the result of repeated removal of sediment from the channels for use in the flood control levees. As the capacity of the channels is reduced by sedimentation, the material is removed and placed on the levees, but the channels are not cleaned out to their original depths.

Concerted national effort for the control of erosion has not yet been made, but the primary objective of the Land Utilization Bureau is to collect information and develop feasible recommendations for soil conservation practices which can be disseminated to the farmers through the extension programs of the various services. In 1930 the Forest Research Station initiated work[1] to determine the role of forest cover in soil and water conservation through rainfall and stream gauging, through plot studies, and through the use of lysimeters. While the measurements on the experimental plots showed a loss of 12 tons per acre, the sediment analysis of the streams indicated a loss of only two tons per acre from the entire watershed. This watershed was a young volcanic forest-covered watershed and the experimental plots were cleared and cultivated with various treatment.

The value of green manure crops for erosion control and soil improvement has long been recognized by agricultural scientists in Indonesia, and the use of a number of plants has been advocated for various purposes. As previously mentioned, the _lamtoro_ shrub has been used in the teak forests to form erosion resisting hedges and for firewood. _Lamtoro_ is also planted or rather seeded by broadcasting on steep slopes or is planted in fields on the terrace banks of some irrigated fields and in rows across the slopes of dry fields (approximate contours laid off by eye) to reduce erosion and to provide cattle feed which is harvested by cutting or breaking off the young

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1. J. H. De Haan, Scientific Investigations Concerning Adequate Water and Land Use, _O.S.R. News_, Oct. 1950, p. 131.

branches. Green manure crops planted in the fields to be turned under include calopogonium, crotalaria, and mimosa; kudzu has been used to a limited degree on some of the estates.

Among the deterrent factors retarding the widespread application of erosion control practices concurrent with dry farming are the low income level of the farmers, the high labor requirements of food crops for the farmers' families, the lack of good tools and implements, the lack of animal or mechanical power which can be utilized for the establishment of the practices, the lack of specifications as to the methods of establishing certain practices, and the lack of specific information as to the benefits of conservation practices.

The annual per capita income of the Indonesian people is estimated at the equivalent of $25.00, but the disparity between the incomes of various population groups is so wide that the average means little. Kaslan has reported the income of the poorest farmers at $25.00, of the middle class farmers at $50.00, and of the well-to-do farmers at $100.00. With farm incomes at these levels it is impossible for the farmers to spend money for materials with which to apply conservation practices. The amount of labor that the farmer and his family must use in the production of the food crops necessary for their existence does not leave much labor available for conservation practice establishment during any one season. If a farm family with two adults

and two children of working age is engaged in dry rice production, a little more than one-half of the available labor is required for this crop alone, excluding the labor required for daily chores. Although seven hours is considered the normal working day, it is doubtful if the productive use of labor exceeds five to six hours. The remainder of the day is lost in travelling to and from the fields and in other miscellaneous ways.

The tools and implements found on the farm are the patjol or broad hoe, perhaps a sickle for grass harvest, and, if the farmer is wealthy enough, one or two cows or carabao. If there is livestock, plows and spike-toothed harrows made from wood are usually present also. With these implements it is very difficult for the farmer to do more than a superficial job of land preparation. Leguminous crops useful for green manure and for erosion control must be cut and allowed to partially decompose on the surface before they can be incorporated in the soil, and even then it is not possible for the farmer to do a good job. Because the primitive tools with which he works limit his capabilities to such a degree, the farmer is reticent to attempt to change his traditional practices as is the case with farmers in other parts of the world. A similar case may be cited in North Georgia; as long as farmers were able to prepare land with one or two horse plows, it was impossible for them to plant winter legumes to be turned under before planting large areas in corn, although demonstrations had shown that this practice would increase the yields obtained. If the farmer planted large areas in winter legumes and the land remained too wet to plow late in the spring, it was impossible for the land to be prepared before the optimum dates for corn planting had passed. The farmer then found it necessary to follow his traditional practice, which did not exceed his capability of timely land preparation, until tractors and machinery were available to insure land preparation for the crop. The increased availability enabled the increased use of winter legumes and also small grains and hay crops in this area, and with the improved practices the production of cotton, the principal cash crop, remained at approximately the same level although the area planted in cotton showed a marked decrease.

In general the desirable rates of seeding of the various soil conserving crops are available, but in some cases the economical levels of fertilization for both the soil conserving and the principal crops are not available. While the lack of information about the use and benefits of soil conserving crops is serious, from the viewpoint of its relative importance upon the effectiveness of the practice, a more serious deficiency is the dearth of specific data upon which to design terraces and waterways through which excess rainfall may flow to the streams without causing serious damage. The system of establishing terraces by the trial and error method has been carried over from the construction of the level terraces for irrigation to the construction of terraces for erosion control. Little attention has been given to the fact that, while good terraces are an effective means of reducing erosion, especially gully erosion, terraces laid out with excessive gradients or in such a manner that runoff is concentrated in unprotected areas, cause for greater damage than if the terraces had never been laid out and constructed.

In spite of the limited information available, the Farmers' Agricultural Service in some areas has considered the problem of erosion control so serious that work has been initiated to whatever degree possible with the cooperation of the people. Wherever such work has been undertaken the Service has furnished the seed, seedlings, fertilizers, and the leadership, while the farmers of the area have generally contributed their labor for the actual work. The outstanding example of such work prior to the war was on the island of Bali where the banks of the ravines were eroding to such a degree that the irrigated fields downstream were being damaged. Through appeals to the villages and with the cooperation of the Government agencies, approximately one million bamboo rhizomes were planted on several thousand acres[1] and the villages agreed to supervise the maintenance of the planted areas after they were established.

In 1952 the Farmers' Agricultural Service in cooperation with the administrative officials of the kabupatens was able to obtain the assistance of the farmers in efforts to reclaim several hundred acres in the area of Wonogiri, Central Java. The Service furnished the lamtoro seed and the fertilizer, and the farmers cooperatively performed the work to construct terraces to plant the lamtoro on the terraces and to construct check dams in the gullies of several hundred acres. It is estimated by officials that between 100,000 and 150,000 acres have been severely damaged by erosion in this territory. The Service is operating an erosion control demonstration farm in this area to show the farmers the benefits of erosion control practices, and a part of the operation of this farm is the nursery which produces the necessary plants for distribution to the farmers for erosion control purposes. While the work that is being accomplished under the existing conditions leaves much to be desired from the standpoint of technical quality, it is certainly worthwhile from the standpoint of demonstration and field investigation. The terraces which have been constructed have been laid out without benefit of surveying instruments, and the same is true for the contours on which the lamtoro has been planted. As would be expected,

1. De Haan, op. cit., p. 2.

the grades of the terraces are neither uniform nor continuous and many low places occur where water is ponded (Figure 67) until it disappears through evaporation or through percolation.

The establishment of conservation practices through the cooperative action of the farmers, the Farmers' Agricultural Service, and the civil administration officials is facilitated to a certain degree by the history of the people and the former governments that have existed. From the historical side of community action the people from ancient times have been accustomed to compulsory labor for road construction or maintenance or to contributing their labor to other community projects as directed by the governments, either the Netherlands Indies Government or that of the princes and sultans which goes even further back in history. Even in the present democratic state the illiterate masses of the people do not question the recommendations of the officials but accept them as orders to be carried out without question provided the recommendations do not conflict with <u>adat</u>. While the Farmers' Agricultural Service may inadvertantly use these traditions of the people, they are endeavoring to demonstrate to the people why they should establish conservation practices through their own free-will and efforts.

On the areas where the farmers have cooperatively established the conservation practices, the Service has

either furnished or helped the farmers to obtain vine cuttings of sweet potatoes or the canes of cassava plants for planting between the terraces and the contours so that there will be some food produced through their efforts. The food shortage in these areas is of such acuteness that any additional food production will benefit the economy of the area.

CHAPTER XIII

AGRICULTURAL MECHANIZATION AND LAND DEVELOPMENT

A. Present Status

Under the influence of a plantiful supply of cheap labor there was little reason in the pre-war Dutch East Indies for the estates to make any appreciable effort at mechanization. On the other hand, the subsistence agriculture of the indigenous farmers was concerned with such small unit areas and the cash income was so low that any thought of use of machinery for field work was impossible. Even on the tobacco and the sugar estates the cultural practices made the use of machinery impractical except perhaps in the land preparation phase of tobacco production. It has been estimated that no more than 200 tractors[1] were in agricultural use in Indonesia prior to the war, and in 1951 the number was estimated at 250, most of which were in use on the estates.

The tractors that have been used in Indonesian agriculture have been used primarily for land clearing and initial preparation of estate land to be planted in tobacco, rubber, oil palm, and fibers. Because of soil and climatic conditions moldboard plows have generally proven unsatisfactory as there is so little time in which the moisture content of the soils is within permissible limits for good

1. Metcalf, op. cit., p. 84.

plowing with moldboard plows. On the other hand disc plows are often used when the soil is either too wet or too dry for the best work, but they have given relatively satisfactory results. The desired depth of plowing of 10 to 18 inches, especially of the land infested with alang-alang grass, has caused a preference for crawler type tractors of sixty horsepower or more. Before the war almost all of the tractors and machinery were from the International Harvester, Caterpiller, or John Deere companies of the United States, but recently representatives of European, Australian, and other American manufacturers have been importing larger numbers of other makes of tractors and machinery.

In the past a negligible amount of attention has been given to the use of tractors and machinery in Indonesia, so little that the only reference obtainable was a cursory discussion by Van Wijk[1]. Prior to 1952, efforts of the Government to determine the feasibility of using machinery was restricted to two projects, one on the island of Muna southeast of Sulawesi and the second on the island of Timor. The principal vegetation of both of these areas was alang-alang grass, and both projects were undertaken as a part of the transmigration or resettlement program of the Government. According to Van Wijk it is necessary to plow to depths of

1. Chr. L. Van Wijk, Problems in Mechanical Tillage of Lalang Plains, Reprint from Tectona, Dl. XLI, 1951, pp. 29-35.

nine to ten inches to adequately loosen the rhizomes of the _alang-alang_ so that the grass will be killed through dessication, but officials of one of the large tobacco estates have recommended 15 to 18 inches as the desirable depth. It is necessary, of course, to follow the plowing with harrowing and perhaps a second plowing and second harrowing in order to reduce the grass to an allowable stand -- complete eradication is impossible without repeated raking, piling of the roots, and burning; however the natural wild stand of the grass can be reduced to such a degree that it does not seriously affect crops and cultivation.

The interest of the people in the use of tractors and machinery, primarily plows and harrows, is such that a number of small tractors are being used in widely scattered locations throughout the country with varying degrees of success and efficiency. Most of the tractors being purchased by individuals are of thirty horsepower or less and often no more than six to eight horsepower. The selection of implements being bought with the tractors usually include some that cannot be used, a condition brought about by the inexperience of the farmers who do not know what implements they can use and by also the inexperience of some of the distributors who do not know what should be used under particular conditions. The inclination of the people when they purchase a tractor is to purchase all attachments that the manufacturer lists in the catalog if they can afford to pay for them and if the importer can obtain the foreign exchange permits to order them. The Government attempts to limit such imports; however, b ecause the importers have an allowance of foreign exchange for the import of introductory items without having to submit detailed lists for approval, a limited amount of equipment can be imported without prior approval. It would be rather easy to criticize the import of unadapted machinery but considered from the viewpoint of experience gained the people, the importers, and the officials, it is not so serious, although in individual cases it becomes expensive experience.

Demonstrations are already proving that garden tractors are not satisfactory for the use under Indonesian conditions. If the tractors are of sufficient size to perform field work, even in small fields, then they are so heavy that the small men cannot handle them. The same difficulty is also present in the utilization of larger tractors; it is impossible for men who average about 63 to 65 inches in height and about 110 to 125 pounds in weight to easily handle tractors designed for Europeans or Americans who average five to eight inches more in height and fifty to seventy pounds more in weight. Basically the same difficulties are confronted in the use of garden tractors by larger men, but in the United States the garden type tractors have found a profitable market in the demand for them for the lighter jobs of cultivation and grass cutting.

B. Relationship of Mechanical Equipment to Land Development

The Indonesian farmer works under conditions which favor rapid growth of vegetation and which, therefore, tend to reduce to a minimum the area which he is able to cultivate. These conditions of continuously warm weather, ample rainfall, and soils of medium to high fertility make it difficult for the farmer to cultivate more than enough land to permit a bare subsistence of the farm family. The population pressure on Java has further reduced the area cultivated to about 1.75 acres, while the natural factors in the Outer Provinces have kept the area from exceeding three or four acres. Irrigated rice fields are the basis of secentary agriculture in Indonesia. The national preference for rice as the principal staple food and the ability of the farmer to maintain irrigated fields at a high level of productivity, in contrast to the rapid decline of production on dry fields, have materially contributed to the importance of the irrigated fields. The alternate flooding and draining of the irrigated fields, together with the close attention given to the rice culture, prevent weeds and grasses from becoming a serious problem in the production of the rice crop which requires approximately six hundred man hours per acre.

In areas where there is adequate water available for irrigation, the seasonal requirements of labor are of secondary importance because planting and harvesting take place side by side throughout the year and minimize any

seasonal requirements. In areas of inadequate water supply the time of land preparation and the time of harvesting are seasons of high labor requirements and tend to reduce the total area that a family can cultivate. The land must be prepared in time for the crop growing season to coincide with the wet monsoon; therefore, the harvest season approximately coincides with the beginning of the dry monsoon. The labor requirement for the preparation of new land for cultivation from alang-alang savanna is approximately 160 man hours per acre; if land cleared from forest were adequately prepared, the labor requirement would be even higher but usually it is not as well prepared as that reclaimed from alang-alang savanna. The rapidity with which the grass or second growth shrub and forest tend to reestablish themselves among the standing stumps and fallen, half burned logs limits the area which can be cultivated by the farmers without the increased use of improved tools and either animal or mechanical power.

If the farmers were able to utilize leguminous green manure crops in rotations on the dry fields, it would be possible to maintain the productive level of the soil; simultaneously, the growth of the legumes would, through competition and shading, eliminate to a large degree the return of the alang-alang grass and the shrub growth. With primitive tools and limited animal power the farmers are unable to adequately plow or otherwise incorporate green manure crops into the soil to enable planting the next crop. Because of the limited capabilities of the farmer, the area cultivated per family in the Outer Provinces has been little larger than that on Java where the restricting factor is the availability of land. The tragedy of this limitation is that it has led to the acceptance of an area of five to seven acres as the standard size farm even in areas where there is plenty of land for clearing. The term tragedy is used to describe this condition because in the absence of irrigation intensive agriculture seems impractical and the agriculture must progress towards a more extensive type of culture, and under these conditions the farmer who is allocated no more than five to seven acres is limited to a type of farming which under favorable seasons will produce enough food for his family and under adverse rainfall conditions will not even produce an adequate food supply.

In order to permit the development of agriculture above the subsistence level, it is desirable that the farmers have available at least enough power to permit the plowing under of leguminous green manure crops in order to obtain adequate, timely preparation for subsequent crops. The desired quality of work cannot be obtained from the use of cattle and carabao as draft animals; the nature of the work makes the use of tractors with harrows and plows advantageous, and the nature of the soils generally dictates the use of disc plows. The educational and financial level of

the farmer, as well as his economic position, make it uneconomical, if not impossible, for the use of even small tractors by individual farmers to become commonplace.

There are three methods of being undertaken to various degrees at the present time by which the farmers of Indonesia will be able to benefit from the increased utilization of tractors and machinery in the near future. The Government is establishing pools of land development equipment to accomplish the initial clearing and land preparation; the farmers will repay the Government for the cost of equipment operation. The land development equipment pools are being operated by the Mechanization Division of the Farmers' Agricultural Service, but in addition the Biro Reconstruction Nasional and the Corps Tjadangan Nasional are establishing resettlement projects for the rehabilitation for former military personnel who have had previous experience as farmers and wish to settle in new locations. The Biro Reconstruction Nasional is responsible for assistance to the irregular soldiers who fought against the Dutch "police actions" between 1945 and 1949, while the Corps Tjadangan Nasional is responsible for assistance to demobilized personnel of the regular armed forces. The Transmigration Service of the Ministry of Social Affairs is also concerned with mechanization and land development projects as they are related to the opening of new areas or the extension of former colonization project areas for transmigration or resettlement of farmers from crowded areas, primarily on Java, to the sparsely populated areas of the Outer Provinces. The programs of these agencies are independent, and because of the vast areas in which they may operate, there has been little conflict of interests to date in spite of the minor degree of coordination that exists.

The second method by which the farmers may benefit from the increased use of mechanical power is through the private ownership of tractors and machinery by enterprising individuals who will perform work in the community on a custom basis. While there are only a few tractors operating under this system at the present time, those that are available are finding plenty of work in their respective areas. One small unit near Medan in North Sumatra charged $7.00 per acre for plowing initially, and gradually raised the rate to $17.50 per acre when the demand exceeded the capabilities of the unit. At this rate, except for inefficient operation, the unit should be completely amortized and return a net profit to the owners in about two years, but even at this high rate the farmers were still having work done at approximately half the cost of the same work if done with hired labor using <u>changkols</u>.

The third method of utilizing tractors and machinery for the benefit of the farmers is that of cooperatively owned equipment by the farmers or villages. This method has not been effectively utilized to date, although the Marga or village chief of a South Sumatra village near Palembang ordered two small tractors to be turned over to his village for the cooperative use of the farmers upon the delivery.

It seems probable that after the initial operations of the Government programs to open new land for the farmers have operated for a time, these programs will not only demonstrate the uses of machinery but will also leave behind in each a number of men experienced in the operation and maintenance of machinery who will be able to obtain and operate machinery, either individually for custom work or cooperatively for their mutual benefit.

C. Program of Division of Mechanization

The Mechanization Division of the Farmers' Agricultural Service is establishing operating units or pools of tractors and machinery for the opening of new land for farmers in all of the Outer Provinces except Kalimantan and will operate equipment in the three provinces of Java to enable the timely preparation of rain dependent rice fields for rice production and upland fields for supplemental food crops. The basic equipment of each operating pool is six track-type tractors of 55 to 65 horsepower and four wheel-type tractors of 25 to 40 horsepower. Disc plows and harrows are the standard equipment for each tractor, and at least one tractor in each pool is equipped with a bull-dozer and at least one is equipped with a winch. At the headquarters of each pool will be established an adequately equipped maintenance shop for the maintenance of the tractors and machinery. Each pool which is located in areas where roads will permit the use of a semi-trailer for transporting the tractors and machinery will be so equipped, but in other areas it will be necessary to drive the tractors over the roads; in some areas the controlling factors will be the bridges, while in others hairpin turns on narrow raods will make the use of the trailers impractical.

The pools are being located in sparsely populated areas of the Outer Provinces where there are large areas to be placed in cultivation which cannot be reclaimed from the alang-alang grass or from the second growth forest by the farmers with their primitive methods of operation. Initially the clearing and preparation of new lands will be for the benefit of the farmers of the particular areas, but as the work progresses, it is expected that because of the greater opportunity people will more from other areas, either voluntarily or through assistance from the Transmigration Service. It is a paradox that even in the sparsely populated Outer Provinces there are areas where the population has become so dense that actual shortages of land exist but the people seldom move because of the difficulty of opening new lands beyond walking distance from their homes. In South Sumatra the presence of tigers is a deterring factor to any tendency on the part of individuals to move away from the villages. It is believed that there will be dispersal of the villages to a greater degree if large enough blocks of land are cleared so that the danger from tigers will be minimized.

After the land is prepared by plowing, harrowing, and clearing of trees where necessary, it will be distributed among the farmers who will plant and cultivate food crops by means of traditional methods and equipment. It is logical that the accomplishment of the initial heavy work of clearing and initial preparation will enable the farmers to keep larger areas in cultivation; they will thereby be enabled to utilize better crop rotations in order to maintain fertility at reasonable levels. In some areas the lands to be prepared are Government owned lands, while in others they are lands to which the people, either as individuals or through community ownership, have acquired certain tenure rights. The program is being received with enthusiasm by the people; in Middle Sumatra the people of one area who had acquired tenure rights through generations of _ladang_ culture voluntarily agreed to relinquish their rights to the land to be cleared in a large block so that it could be redistributed in a manner which would permit the consolidation of scattered fields into single units of sufficient size for a farm family to cultivate with more efficiency.

The pools located in the provinces of Java have a different objective; there is little arable land which is not in cultivation, but there are thousands of acres cultivated as sawah tadahan or irrigated fields dependent upon the retention of rainfall during the wet monsoon for rice culture. Because of the nature of the soils and also because of the fields having been worked when wet in previous years, these fields are so hard during the dry monsoon that the farmers cannot begin preparation either with the changkol or with animal-drawn plows and harrows until the rainy season has begun. Because the preparation of the land requires six weeks to two months, the wet monsoon is about one-third over at the time of planting. The rice does not mature then until the wet monsoon is almost over; it is so late that there often is insufficient moisture for the crop to mature under favorable conditions; therefore, the yields are materially reduced.

The plans for the equipment on Java are to prepare the land of the sawah tadahan areas before the beginning of the wet monsoon so that the planting dates and harvesting dates may be advanced at least a month and possibly six weeks. Because rice maturing earlier in the season will mature under more favorable moisture conditions, is is estimated that the yields will be at least 50 percent greater. In order to insure the year round utilization of equipment, land will be prepared for the planting of secondary food crops except during the last half of the dry monsoon.

The plan for the use of wheel and crawler tractors together in pools with a ratio of four wheel-type to six crawler-type tractors was determined by the Indonesian Government based upon the limited experience of the estates and the recommendations of the various machinery manufacturers. It seemed logical that there should be more of the heavy units for the initial clearing and plowing than of the lighter units for the subsequent harrowing and plowing. Limited experience to date, April 1953, has not yet proven whether this is the desirable balance or not, but there are indications that perhaps wheel-type tractors in the 25 to 30 horsepower class may be preferable to the larger tractors because of the physical limitations of the tractor operators. Because of very limited experience prior to the purchase of tractors for use in the Lesser Sunda Islands and the need for tractors to arrive simultaneously on four of the islands, it was deemed necessary to order smaller tractors with kerosene burning motors for this province. Maintenance facilities do not exist on any of these islands; maintenance personnel, as well as operators, must be trained. The areas of initial operations have no vegetation more formidable than grasses other than _alang-alang_ grass as the severe dry monsoon retards vegetative growth. The use of the smaller types of tractors will minimize the need for large stocks of spare parts on each island; the smaller items most commonly needed can be stocked on each island, but others may be stocked in a central point for delivery by air freight on the weekly planes as necessary. The use of the smaller tractors will also facilitate the moving of equipment from one area to another over the roads; most movement will be over the roads where the bridges are inadequate for heavy trucks or trailers.

At the time the implementation of the program began in 1952, it wa realized that a program of training would be necessary to provide supervisory, operating, and maintenance personnel for the efficient utilization of the equipment. In order to fulfill this need, the Mechanization Division established a school at Pasar Minggu near Djakarta with the primary objective of training supervisory personnel for the pools. After receiving training at the school, these men completing the course would conduct training for operating personnel as a part of the field operations. Although in the original planning for the establishment of the school the training of maintenance personnel was contemplated, this type of training has been beyond the initial limitations of personnel and equipment available for instructions, and at least for some time it will be necessary to obtain maintenance personnel from the technical high schools and from automotive repair shops.

The duration of the courses at the school is approximately three months with the emphasis on practical operation and preventive maintenance with a minimum of theoretical training. In addition to training personnel for the immediate needs of the Mechanization Division, the school is admitting employees from other Government agencies, such as the Biro Reconstruction Nasional and the Corps Tjadangan Nasional and in the future will also provide training for the general benefit of the Ministry of Agriculture and for individuals besides government employees. It has been suggested that graduates of the agricultural high schools and colleges, upon starting work for the Farmers' Agricultural Service, will be sent to the school for practical training in the use of farm power and machinery before being assigned to their permanent duties.

D. American Assistance

The concept of the bold program to utilize tractors and machinery for the benefit of the farmers originated in the Ministry of Agriculture; the general framework and scope of operations were outlined and invitations to submit bids were issued on some of the equipment prior to the arrival of an agricultural engineer with the Special Technical and Economic Mission to Indonesia. As previously referred to, this Mission was initially under the administration of the Economic Cooperation Administration; later it was transferred to the Mutual Security Agency and subsequently to the

Technical Cooperation Administration. Discussions about the program early in 1952 developed into mutual agreement that the Indonesian Government had budgeted enough funds for the purchase of capital equipment and that the most benefit from the available United States funds could be derived from the expenditure of these funds for technical assistance and training. To implement this type of assistance, two projects were developed before the end of the fiscal year 1952.

The first project provided that 14 Indonesians would be sent to the United States for approximately eight months' training in the operation and maintenance of tractors and machinery with as much related training in surveying, soils, soil conservation, and other pertinenet subject matter as possible. The Indonesian Government paid the cost of transportation to and from the United States and other incidental expenses, while the United States paid the cost of the training and travel within the United States and provided the trainees with a per diem allowance adequate to care for their living expenses while in the United States. The Food and Agriculture Division of the Mutual Security Agency contracted with the California Polytechnic Institute at San Luis Obispo, California for its Department of Agricultural Engineering to arrange a special six months' course of instruction especially designed to meet the needs of the trainees and adapted to their lack of previous mechanical

experience. Because of the transfer of the Mission in Indonesia from the Mutual Security Agency to the Technical Cooperation Administration the implementation of the program for the trainees was under the supervision of the Office of Foreign Agricultural Relations (changed to Foreign Agricultural Service in 1953) of the United States Department of Agriculture.

Upon the termination of their training in California, the trainees travelled through the southern part of the United States spending four weeks in Texas and two weeks in Florida observing various projects where land clearing, soil conservation, and irrigation operations were utilizing different types of machinery. After their return to Indonesia in March 1953, the men were assigned to the areas where their knowledge could be utilized in the machinery operation program. Two men were assigned to the school at Pasar Minggu to conduct instruction, but one has the secondary duty of general supervision of the field operations of the equipment working in West Java.

The second project developed under the 1952 program obligated funds for ten American technicians to work with the machinery program in Indonesia for one year and also provided a small amount of money for the purchase of text books and other miscellaneous needs of the school. The first American technician for this project, an agricultural engineer, arrived in Indonesia in November 1952 to serve as

advisor to the school director and to assist in the instruction. Because of the lack of qualified Indonesian personnel prior the the return of the trainees from the United States, it was necessary for this technician to conduct most of the instruction of the December 1952 to March 1953 course taught at the school, and in spite of alnguage difficulties the fifteen men who completed the course learned the basic principles of motors and machinery and acquired sufficient skills to permit them to safely operate and perform preventive maintenance for tractors, harrows, plows, listers, and bull-dozers. Subsequent courses taught by Indonesian instructors assisted by the American agricultural engineer should be even more effective. It is planned that American assistance will be continued at this school until there are enough well trained Indonesians to continue its operation without loss of efficiency.

The nature of the duties of the remaining technicians under the technical assistance project of 1952 are as follows: one maintenance instructor and shop foreman for the school at Pasar Minggu, four field operation supervisors and four field maintenance foremen to work with the land development equipment pools which are using American manufactured equipment. It was included in the terms of the purchase contracts that distributors of European manufactured equipment would furnish technicians for a year to assist in training Indonesian personnel to properly operate this equipment after its delivery.

E. Government Agricultural Estates

The Pusat Perkebunan Negara or Government Agricultural Estates is the operating agency for all government estates, and on the various estates there are many varying degrees of mechanization and many different types of machinery used in processing the commodities in preparation for marketing. The principal estate of interest because of its mechanized field operations is the Lho' Sukon estate north of Medan in the province of North Sumatra. Prior to the war this was a privately owned estate engaged in the production and processing of fiber crops; however, during the war and subsequent "police actions" the houses, other buildings, and processing equipment were destroyed, and after the war the estate concession was in the hands of the Government. In addition to the poor condition of the estate buildings the fields had returned to shrub vegetation, and the irrigation system and the roads had become useless for lack of maintenance so that any further use of the estate required complete rehabilitation.

In addition to operating estates for the production of agricultural commodities for domestic consumption and for export, the Government Agricultural Estates has the responsibility for the conduct of experimental enterprises to determine their applicability for other estates. Because of this aspect of the organization and the need for increased

food production, Lho' Sukon was selected as the location for the development of an estate engaged in completely mechanized production of rice. The estate can eventually have 25,000 acres in production of rice or other crops under climatic and soil conditions that favor the production of two rice crops per year. In 1952 rehabilitation began on the estate -- restoration of living quarters for the supervisory personnel, construction of shops and storage sheds for machinery, repair of roads, repair of the irrigation system, and the clearing and preparation of the fields to enable planting rice on approximately 1,000 acres in August 1953 to be harvested in December 1953 or January 1954.

Mechanized rice production on Lho' Sukon will prove whether or not rice can be profitably produced with modern machinery and methods under Indonesian conditions. If rice production proves profitable under these conditions, it may be expected that similar estates will be established in other sparsely populated areas, especially in Sumatra, Kalimantan, and Sulawesi. In these provinces there are millions of acres of arable land not cultivated or, if so, under the careless <u>ladang</u> culture which scarcely touches the potential yield. In the initial operation of the estate it is planned that the land preparation, seeding, and harvesting of the crop will be accomplished with machinery. Experimental work will be conducted to determine the feasibility of cultivation with machinery and to determine the most economical methods

of cultivation, whether by machinery, by hand, or by a combination of the two and, if the latter, how much of each. Pending proof of the overall economy of the enterprise, it is planned that the first crop will be spread on the concrete floors of the former estate processing plants for drying. If the initial operations indicate success, drying equipment and improved type storage bins will be installed for the processing of subsequent crops.

F. Land Drainage and Reclamation

Included in the undeveloped natural resources of Indonesia are the low lying lands of Kalimantan and Sumatra. While there are other areas of swamp lands, they are relatively unimportant because they are small in comparison with the swamp areas of these two provinces. Plans for the reclamation of 2,000,000 acres in the next fifteen years have been made in South Kalimantan, and work has been initiated on the first 1,000,000 acres. There is a total of 5,000,000 acres of low land in this area, but before plans can be made for the expansion of the reclaimed area, detailed hydrological data must be available to permit further planning to be coordinated with plans for flood control. On the east coast of Sumatra there is an additional area of at least 10,000,000 acres of low land, much of which has high potential agricultural value.

The plan for reclamation of the low land of South

Kalimantan is patterned after the reclamation projects in the Netherlands, such as that of the Zuider Zee and other polder projects. A polder is an area of land protected from high waters of floods or tides by dikes, and to provide internal drainage, drainage canals must lead to automatic valves through the dikes or to pumping installations. Because the primary objective of land reclamation on Kalimantan is for irrigated rice production, the polders must be constructed so that excess water may be drained during the wet monsoon and additional water supplied during the dry monsoon; however, stations 18 and 19 of Table III indicate that there are only three months in the year that irrigation would be necessary.

There are three distinct types of low lands in South Kalimantan where polders have been planned. South of the capitol city of Bandjarmasin are the tidal swamps, areas where the land between the interconnected streams are flooded once daily from the river back-waters at high tides which are almost ten feet above the level of low tide. In these areas levees will prevent the flooding of the land at high tide and control gates or valves will permit drainage at low tide. The same system of valves may be used to enable gravity irrigation as necessary from the flood tide waters throughout the year, but in the opinion of Dr. Schopuys, who has prepared the polder plans, the gravity drainage and the gravity irrigation will be insufficient and pumps must be

installed to insure quick drainage or adequate water for irrigation.

The Kelahien polder area is approximately 150 miles inland on the Barito River. At this location the difference between the high tide and low tide is only eight inches and is of no consequence as the river banks are ten to twelve feet above the water level during the dry monsoon, but this area is subject to flooding because of the sustained runoff from the river's headwaters during the wet monsoon. In this area levees must be constructed to protect fields from the flood waters, and although the high waters will permit irrigation by gravity approximately six months each year, irrigation during the dry monsoon must be accomplished entirely through the use of pumps.

In the vicinity of Negara, fifty miles northeast of Bandjarmasin, the swamp area is characterized by the sedges and grasses typical of areas which have such continuously high water tables that shrubs and trees have never become established. This area is not subject to major influence from the tides but is covered to much greater depths during the wet monsoon than during the dry monsoon. The control of water in this area will require pumps for drainage throughout the year and for some irrigation during the dry monsoon, but irrigation can be accomplished largely through gravity flow during the wet monsoon. The swamp area of this type varies in width from ten to twenty miles and is approximately 85 miles in length. Small areas that the farmers have been able to reclaim and cultivate have given excellent results, but the area under cultivation is so small that the average size farm is little, if any, larger than the average Java farm. For all of South Kalimantan Schopuys[1] estimates that the population of 1.2 million cultivates only 375,000 acres.

The initial work necessary in each of the areas will be the excavation of straight canals for surface drainage, some of which will be entirely new channels but others will replace the meandering channels of the natural streams. Because the principal means of transportation of the farmers of the area is by small boat or dug-out canoes, these straight channels will immediately become the roads for the farmers to travel to new lands which are to be reclaimed. Simultaneous with the excavation of the primary and secondary channels will be the construction of levees with the spoil material of the channels. From 1950 until the present time the clearing of the right of way for the channels and the levees and the initial excavation have been accomplished by hand because of the lack of equipment in order to expedite the use of equipment upon its arrival. On channels started with hand labor (Figure 68) a berm of approximately twenty

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1. H. J. Schopuys, Regional Development Corporation Polderplan Kalimantan, Djakarta, Feb. 8, 1953, Mimeograph, pp. 1-7.

Figure 68. Farmer carrying mud from channel across berm to levee in Mantaran Polder, South Kalimantan

Figure 69. Grass swamp area within area of Alabio Polder, South Kalimantan

feet is left between the channel and the levee to provide solid footing for a dragline to be used later for enlarging the main canals and the levees. Initially the channels have been excavated to a depth of about three feet and will be subsequently excavated to depths of six to ten feet through the use of draglines or dredges.

Under the leadership of the Inspector of the Farmers' Agricultural Service for Kalimantan the farmers of South Kalimantan organized cooperative polder organizations for the development of small sections of the individual polders. Under agreement with the Farmers' Agricultural Service and the provincial government the farmers were to pay into these organizations $14.28 per acre with the remainder of the estimated cost of $70.00 per acre to be paid by the Government. At the time of the author's visit to the area in 1951 the farmers were paying their contribution to the associations either in cash from the income of the rubber gardens at the rate of $1.75 per month or were receiving a wage credit for labor on the canals and levees which was of general benefit to the project. The actual clearing of the land that the farmer would be allocated under this system was the responsibility of the farmer who would cut the trees and shrubs and, when they were dry enough, dispose of them by fire. It was reported that the farmers could contract for as much as 12.5 acres under this system.

Most of the work to date has been accomplished on three polder areas, one in each of the three distinct terrain conditions. The southernmost of these is the Mantaren Polder with an area of about 5,750 acres on the east bank of the Kahajan River and south of the Kelampan Canal. The initial excavation of the canals around the polder had almost been completed in October 1951, and the surface drainage resulting from the small canals had permitted the clearing and planting of a few acres in rice and cassava at that time. The principal type of trees to be cleared in the Mantaran polder are galam, most of which are six to eight inches in diameter.

The Kelahien Polder of 12,500 acres in the flood swamps of the Barito River 150 miles upstream is covered with mixed tropical rain forest with many of the trees 18 inches and larger in diameter. In this area there is high ground about 4.5 miles to the east of the river and the northern project boundary is a straight line from the river to the high ground. The right of way for this main levee had been cleared in November 1951, but only a small amount of excavation had been accomplished at that time.

The Alabio Polder of 17,500 acres lies to the north-east of Negara in the grass swamp area (Figure 69). Work on this polder was initiated prior to the war, and in 1951 the levee surrounding it for protection from the river flood waters was complete. This levee, which has a total length of about 16 miles, was constructed with a top width of ten

to twelve feet and also serves as a road; the levee height varies from about four feet to about eight feet. Gravity control structures were completed for this polder but are not completely satisfactory in that drainage is inadequate during the rainy season. The precipitation within the area is in excess of crop requirements, and without pumps to facilitate drainage the lowest areas cannot be cultivated, and crops planted in the areas of intermediate elevation are usually damaged seriously two years out of three so that farming within the polder still more or less follows the ladang culture.

Within the Alabio Polder area the canals for drainage and for irrigation have not yet been constructed and probably will not be until the pumps are installed to guarantee the control of the water level. It is estimated that the pumping requirements for this polder will consist of three installations primarily for drainage, each with a capacity of 30 cubic feet per second and two reversible installations each with a capacity of 40 cubic feet per second. All pumps will operate against maximum elevation heads of about nine feet. The estimated cost of purchasing and installing the pumps is $300,000 or slightly more than $17.00 per acre, but the value of the potential rice production of the area is approximately one million dollars per year. If the cost of the land reclamation for the project, other than the pump installation costs, does not exceed the estimate of $70.00

per acre previously referred to, the total cost of the polder development will be approximately $1,700,000, and if 20 percent of the cost is paid by the farmers for land tenure rights, the remainder would be amortized without interest in about 25 years from the 5 percent income tax paid by the farmers of this area.

In addition to the relatively large polder projects referred to above, plans have been made and work has been initiated on 25 smaller areas, such as the Ampukung Polder which was completed in 1951. The Ampukung Polder in the grass swamp area was favored by its relatively high elevation so that it was subject to flooding to depths of no more than one to two feet. In 1951 a levee no more than three feet in height with a 1.5 foot top width and one to one side slopes was constructed through the cooperation of the farmers of the area and the Farmers' Agricultural Service. The Service contributed $2,200 with which to pay the farmers for the cost of their labor calculated at one-half the usual daily wage rate for labor in the area; no materials were necessary for this polder. Because the area was not subject to flood damage in the wet monsoon of 1951, the rice crop matured without flood damage with a yield estimated at 880 pounds per acre. Local officials stated that the income tax paid by the farmers of this area from the income of the crop would be about $3,600, income to the government that would have been reduced at least

80 percent had the levee not been constructed.

The improvement in existing irrigated rice fields and the development of new irrigated rice fields totalling more than two million acres have been planned for completion over a fifteen year period to begin in 1954. The purchase of dredges, draglines, boats, barges, landing craft, tractors and allied machinery, and the construction and equipping of maintenance shops, and the training of personnel that have already been accomplished are exploratory and preparatory for the real development effort to begin in 1954. It is with considerable personal pride that the author notes in the latest information of the Polderplan Kalimantan that the establishment of three land-grant schools is included as a definite part of the program. The land grants of 1,250 acres, 7,500 acres, and 10,000 acres will be for the establishment and operation of three agricultural schools as vocational schools and agricultural colleges. While the officials of Kalimantan recognized the need of educational institutions to support the agricultural development program, it is almost certain that the allocation of these large tracts of land to be dedicated to the establishment and support of the institutions may be traced to discussions of the officials with the author and two members of the agricultural staff of the Economic Cooperation Administration Mission to Indonesia in October 1951 and to subsequent discussions by the staff members with officials of the Central

Government. A statistical summary of the work that has been planned towards the agricultural development of Kalimantan from 1954 to 1968 is given in Table VIII.

The method of obtaining the staff of technically trained personnel, engineers, pedologists, surveyors, machinery operation and maintenance specialists, agricultural economists and others will, in the opinion of the author, lead to many difficulties both from the standpoint of recruitment of personnel and in the actual development of a well balanced team when the specialists can be assembled. Under present policy personnel from several countries are being recruited on an individual basis under contracts varying in length and other details which to date include the Netherlands, Switzerland, and France. The scope and nature of the work will require a high degree of understanding and cooperation among the staff, and to the author it seems highly probable that technicians who have been educated in different countries have acquired experience in different approaches as the correct method of solving particular problems. Undoubtedly there are several acceptable methods for the solution of many of the proglems that will arise in the polder development, but it is doubtful whether an international staff can agree and cooperate to effectively carry out any one solution. This personnel problem may be even more acute than seems likely at a casual glance because of the severe shortage of technical Indonesian personnel to actually make final decisions that certain procedures will be used.

TABLE VIII

COSTS AND BENEFITS OF POLDER DEVELOPMENT ON KALIMANTAN

Expenditure or estimated results	First five years	Second five years	Third five years	Total
Estimated total expenditure (millions of dollars)	40.4	94.7	75.9	211.0
Area of existing rice fields improved (thousands of acres)	175.0	37.5	87.5	300.0
Area of new irrigated rice fields (thousands of acres)	575.0	792.5	575.0	1,942.5
Increased annual rough rice yield (1951 base, thousands short tons)	319.0	506.0	385.0	1,210.0
Value annual increased production (millions of dollars)	38.1	60.5	46.0	144.6
Ratio value increased annual production to estimated development cost	0.76	0.64	0.61	0.655

H. J. Schopuys, Regional Development Corporation Polderplan Kalimantan, Feb. 20, 1953, Chapt. II, Mimeographed, pp. 1-10.

A deficiency that is recognized by the personnel currently working in the polder development program is the initiation of work with inadequate design for various engineering structures and with inadequate supervision for the actual work in progress. For example, information is lacking as to the angle of stability of the various types of soils that will be in the channel banks and will be used in the levees. The supporting capacity of the soil and its tendency to flow into the channels under the pressure of the levees have not been investigated. Flood routing studies have not been made to determine the effect of channel restriction on the flood crests, and although the area presently included in the development plans covers less than one-half of the entire swamp area, hydrologists should certainly be among the early arrivals of the personnel. On a visit to the area in October 1951, the author observed farmers excavating canals by hand and carrying the excavated material to the levee banks in the Mantaren Polder. The site of the levee base had not been cleared to a firm base in many locations, and often there had been no effort to remove stumps, roots, or organic matter from the levee line; in fact, in a few places the farmers were actually using peat material in the levees. It is obvious that levees constructed in such a manner will be a constant source of trouble through excessive settling, bank caving, and seepage until corrected. While the determination of the officials

and the people to work for the improvement of existing conditions is commendable, the wisdom of undertaking projects even larger than those previously referred to with inadequate preliminary surveys and design is, to say the least, questionable.

Governor Moerdjani of the Province of Kalimantan and representatives from the People's Councils (district representative bodies) are attempting to improve the overall program of development of Kalimantan[1] through the medium of requesting the Central Government to authorize the formation of a semi-autonomous organization to direct not only the agricultural development through the polder plans but also the development of other phases of the economy, including forest and mineral resources. It is their recommendation that this organization be generally patterned after the Tennessee Valley Authority and provided with a budget adequate to permit the development of more complete plans and specifications and the employment of such individuals or companies as may be necessary for the implementation of the plans. It seems likely that the work can be expedited if contracts can be negotiated with engineering contracting corporations to execute the preliminary survey and design phases of the development and at least the completion of the initial projects.

1. Djawatan Penerangan Propinsi Kalimantan, Pembukaan Kalimantan, Bandjarmasin, Dec. 1951, pp. 1-28.

From limited observations in the Barito River watershed, it is in many respects comparable to the American elementary school history book descriptions of the lower Mississippi Valley of the early Nineteenth Century. The transportation of the area is by water, the soils generally are fertile, the forests above the tidal swamp offer many valuable products to be exploited when there is transportation, and in the interior of the great island there are mineral resources for future development. Even the legendary paddle wheel steamers are still operating on the river.

CHAPTER XIV

PROCESSING OF FARMERS' PRODUCTS

A. General Conditions

The description of processing techniques of agricultural products and equipment which follows is restricted to those of the small farmer. This restriction has been necessary because of lack of time to study the industrial type operations of the estate processing plants and, at least to some degree, is desirable because the complexity of the specialized processing techniques of many of these plants removes them from the general field of agricultural engineering. Because of the importance of processing the food crops produced by the farmer and the increasing importance of processing the farmers' production of agricultural commodities for export, improved applications of engineering in either farm processing equipment or in small processing plants offer the greatest possibility of general benefit to the rural economy of Indonesia.

The processing of commodities by the farmer, either for home consumption or for market, is characterized by the use of primitive techniques and by the minimum possible investment in equipment, just as is true in field production techniques and equipment previously described. The processing techniques and equipment cannot fail to further impress the observer that the typical economy of the Indonesian farmer is a subsistence and barter economy with a minimum requirement for the consumer commodities considered essential to a minimum standard of living in some parts of the world.

The processing of products for home consumption is normally considered the work of the women and children except for a few processes in which the labor is so heavy that it must be accomplished by the men. Processing is further characterized by being continuous with the amount processed at one time being determined by the daily food requirements of the family or the weekly requirements for material necessary for barter for the few commodities that cannot be produced at home.

B. Rice Processing

Indonesia consumes approximately eight million tons of rice annually. Based upon the estimated population distribution, 70 percent engaged in agriculture, it may be estimated that about five million tons are consumed annually by the farmers, almost all of which is processed on the farm. The five to ten percent of the total rice requirement that is imported is milled rice which, with the rice processed in the more than five hundred rice mills on Java, furnishes the rice consumed by the urban population. Only in rice deficient areas and on some of the agricultural estates do

the farmers or the farm laborers normally consume milled rice. In the deficient areas the rice distributed through the Food Distribution Foundation of the Government normally is milled rice, and the estates often purchase milled rice for distribution to their labor.

After rice has been harvested with the ani-ani knives, it is carried to the farmer's home, and daily thereafter the women and children place the bundles in open places for drying until the moisture content is low enough to permit safe storage in the lumbung. The period of drying is, of course, dependent upon the season but usually is no more than three weeks. The bunches of padi are placed on grassy spots, road shoulders, bridge bannisters and abutments; sometimes the padi is placed on soft woven mats to prevent the loss of even a few grains. It is the job of the children to guard the rice while it is drying to protect it from birds, ducks, chickens and animals that with few exceptions are never penned. If, after the harvest, the farmer needs money for taxes, clothing, salt, or other essentials, enough padi is disposed of either through sale or barter to obtain these essentials. The remainder of the rice crop is placed in the lumbung until used by the family.

Daily the farm women remove enough rice from storage for the food requirements of the family. The padi is placed in a wooden mortar and pounded with a bamboo or a wooden pestle until the straw and husk are sufficiently loosened

to permit winnowing. The mortar usually is a log with a long channel cut in the side of it, and the padi is placed in one end of the channel and gradually moved to the other end. Some of the straw is thrown out as the pounding progresses so that only the rice and chaff remain at the end of the process. In some areas the mortar is cut in the end of a log instead of in the side. The kind of mortar and pestle is usually determined by local custom with various types of wood or bamboo being preferred in the different localities. In some areas the mortars are in almost every farmyard, while in other areas the women gather at the community mortars (Figure 70) in the morning for their daily rice pounding so that the processing takes on the aspect of a social gathering.

The pestle usually is made from a heavy wood, but in a few areas some of the giant types of bamboo are used. If from wood, the pestle is about six feet in length and is tapered from about four inches in diameter on each end to a diameter of about two inches in the center. The pestle is half-thrown, half-dropped with a rhythmic motion as the women change hands between strokes and produces the sound of a drummers' chorus when several women are working in a group.

After the rice is pounded, it is placed on shallow, slightly concave, circular trays woven of bamboo for winnowing. The women winnow the rice by pitching it into the air with a

Figure 70. Women of Central Sumatra village pounding rice

Figure 71. Undershot water wheel for North Sumatra rice pounding mill

slight angle towards themselves so that the tray can be brought a little closer to the body to catch the heavy grain while the chaff and straw, which are lighter, travel a shorter horizontal distance and fall to the ground beyond the tray.

Two exceptions to the usual rice pounding and winnowing methods have been observed by the author; while there may be others, these are worthy of mention. In North and Central Cumatra there are many water driven rice pounding mills similar to that shown in Figures 71 and 72. The undershot water wheel is fastened to the end of the wooden shaft from which extend the wooden studs that mechanically lift the wooden pestles which, falling under their own weight, pound the padi. The other notable exception to the usual techniques was observed in South Kalimantan where the people use hand turned fanning mills for the separation of the grain and the chaff.

While the above method of processing rice is expensive from the standpoint of labor consumption, there has been one material benefit to the population from the poor job of milling that is obtained. Beri-beri and other vitamin deficiency diseases are almost completely absent among the rural population whose principal food is pounded rice. This beneift is attributed by health authorities[1] to the presence of a large percentage of bran on the rice prepared by

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1. U. S. War Dept., op. cit., p. 30.

Figure 72. Interior of North Sumatra rice pounding mill showing wooden shaft and studs for lifting wooden hammers

Figure 73. Foot driven grater in small Central Sumatra coconut oil mill with grated coconut meat on floor

pounding. The rice prepared in this manner has a reddish cast and retains a bran flavor when cooked, but this flavor is not particularly objectionable when the rice is served with several vegetables, fish and perhaps chicken or other meat, all of which are highly seasoned with red pepper.

C. Corn and Cassava Processing

Although corn and cassava are, exclusive of rice, the most important food crops of Indonesia, the processing of these products is of very minor consideration to the farmer. The essential elements of the processing of these two commodities for home consumption are drying and pulverizing. While before the war the equivalent of more than a million tons of cassava roots was exported annually to the United States, the processing was accomplished entirely by estates from their own production often supplemented by the purchase of raw products from the farmers for processing only.

After the corn is harvested, it is air dried by continuous exposure as it is either tied over bamboo racks or around trees, a system which also provides a means of storage (Figures 41 and 42). Cassava, on the other hand, requires more preliminary treatment. The roots are peeled, cut in pieces, and placed in the sun to dry; small roots are quartered and large roots are usually split in eighths.

The final processing of corn and cassava is accomplished with the same mortar and pestle used for pounding rice. Cassava meal is often grated instead of pounded. The finished product is a coarse meal used for bread, pudding, and thickening for soups, and it is sometimes mixed with rice to make this preferred staple food last longer. The cassava meal, commonly referred to as gaplek, is screened to remove the coarsest particles.

D. Coconut Oil and Copra Processing

The comparative ease with which coconut oil for cooking may be obtained is perhaps typical of the various factors which make living in the tropics at a subsistence level much easier than in more adverse climates. When the meat of the fresh coconut is grated, warm or hot water added, and the mixture squeezed between the hands and boiled in an open pot until the water has evaporated, the residual oil obtained is of sufficiently high quality that it may be used for almost any type of cooking. Coconuts processed in this simple manner yield between five and eight quarts per hundred coconuts or, expressed in terms of yield per coconut tree, this would amount to about three to four quarts per tree annually. Although families which normally can afford to purchase oil for cooking in the markets do so, during the Japanese occupation many Indonesians found it necessary to revert to this simple method of obtaining oil because the price of the limited supplies available in the markets was so high that they were unable to purchase the oil.

A small processing plant observed in operation near Bukit Tinggi, Central Sumatra was producing about thirty gallons of oil daily for the nearby markets with the simplest of equipment. As shown in Figures 73 through 78, the equipment consisted of graters, a roller type press, burlap cloth used for wrapping the grated meat prior to pressing, and two fifty gallon steel drums placed over homemade brick fireplaces. The building was small, without lights, and although the principal framing members were of wood, most of the structure was made from bamboo and the roof was thatch. The market value of the daily production of the small plant was approximately sixty dollars per day, while the cost of production was about forty dollars per day. The figures are estimates of the author but are based upon local information as to the cost of labor and the price of coconuts in the area at the time of the observation in July 1952.

The graters were of especial interest because they combine the versatility of bamboo with steel to make an effective machine. The half-egg shaped cutter head, while of wood, had six saw-toothed steel blades attached to it which cut the soft meat from the half coconuts when they were pressed against the rotating head. The cutter head was affixed to a wooden shaft which in turn was mounted in two wooden bearings near the top of two wooden stakes set in the tamped earth floor. About six feet to one side of

Figure 74. Side view of graters in operation

Figure 75. Grated coconut meat being rolled in burlap for pressing

Figure 76. Burlap wrapped meat being fed through wooden geared roller mill

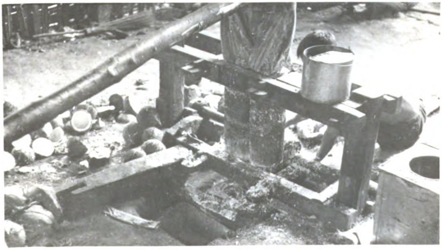

Figure 77. Coconut oil and water are removed from container beneath mill with dipper

Figure 78. Coconut oil is cooked in iron drums without spigots

Figure 79. Coconut husk being removed by striking on a sharp steel spike

the mounted cutter head, a piece of heavy bamboo was driven into the ground; two feet above the ground the bamboo was split so that, when bent towards the cutter one strip of bamboo could pass between the posts below the cutter shaft while the second strip of bamboo was above the cutter shaft; a thong was tied between the two strips of bamboo and wrapped around the cutter shaft to provide a means of rotating the shaft. The operator used the lower strip of bamboo as a pedal and simultaneous with pressing the pedal downward with his foot he pressed a half coconut against the cutter head to obtain the grating effect; after the downward stroke, pressure of the coconut against the cutter head was reduced and the resilience of the bent bamboo returned the pedal to its starting position. The three graters working in the plant would grate approximately one thousand nuts per seven hour day.

After the coconut meat was grated it was rolled in a burlap cloth and passed between the two wooden press rollers of the wooden geared roller mill. The pressure between the rollers was adjusted by the use of wedges on the upper bearings of the rollers. The cloth wrapped meat was passed between the rollers a total of five times; between each pressing the cloth roll was tightened and water added to the meat to increase the amount of oil extracted. The mixture of oil and water collected below the press was then placed in one of the two fifty gallon drums for evaporation;

while evaporating the water, the oil was partially cooked and eliminated the possibility of its souring within a few days. The by-product of the plant, the pressed coconut meat, is utilized as high protein livestock feed with the greatest part of it being fed to chickens and hogs.

Copra production and processing is of little importance on Java; the production of coconuts on this densely populated island is consumed fresh or utilized as a source of cooking oil; the consumption of fresh coconuts here includes those used almost everyday in the Indonesian cooking. In the Outer Provinces and especially in those where there is a sparse population and a marked dry season, as is true in North Sumatra, North Sulawesi and in the Lesser Sunda Islands, copra is of major importance in the local economy.

The processing of the coconuts for copra consists of removing the meat from the nut and drying it either in the sun or in kilns until the moisture content is low enough to permit storage and shipment without loss through fungi formation. The outer husk of the coconut is removed by hand, a laborer hits the coconut against a sharpened iron spike (Figure 79) set firmly in the ground which cuts off large pieces of the outer husk. The inner shells of the coconut are cracked or split on the same steel spike and the meat removed for drying. Sun-dried copra is preferred because it is of higher quality than that obtained by kiln drying; however, it should be noted that the kiln-dried copra is produced by a combination of heat and smoke, not the simple application of heat. The sun drying of copra (Figure 80) requires about five days if the weather is favorable but may require as much as ten days if there is rain accompanied by periods of high relative humidity. The copra, usually on racks or flats, is placed under framework with hinged sections of thatch, or individual sections of thatch roofing material may be placed over the framework to protect the copra from heavy rains. If inclement weather delays the drying, the quality of the copra is reduced.

A small amount of the by-products of copra production, the outer husk and the inner shell, is utilized, but the greatest percentage presents a problem of disposal. The outer husk may be retted in brackish water to permit the extraction of coir, a coarse fiber used for matting and sometimes for ropes if no great tensile strength is required, but more commonly it is used a fuel, especially if the copra is kiln dried. The inner shell is utilized for cups, buttons, or other utensils or ornaments and can also be made into charcoal valuable for filtration purposes. Rubber farmers who are unable to purchase aluminum collecting cups often use the inner shell as cups for their latex collection.

E. Sugar Processing

The contrast in production techniques between the mills

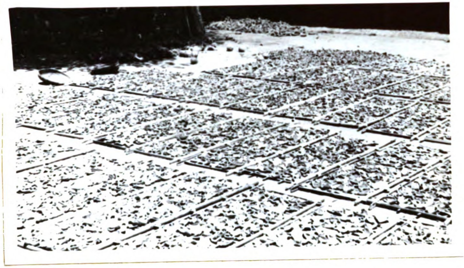

Figure 80. Copra spread on flats for sun-drying in Bali

Figure 81. Small wooden sugar mill operated in South Sumatra by manpower

of the sugar estates and the mills of the farmers is as great as the contrast in production techniques previously described. Just as the greatest development of the large sugar industry has been concentrated in Central and East Java, the greatest advancement in techniques and equipment of the farmers for the production of lower grades of sugar for domestic consumption are to be found in these areas also. Another important source of sugar for consumption by the rural population of the Outer Provinces is from the several varieties of palm whose cut blooms yield enough "sugar water" to permit processing.

The usual technique of processing palm sugar perhaps requires less equipment than for any other type of sugar. The blooms are cut and either a bamboo tube or a liquid tight basket made from a palm leaf is hung beneath the bloom to collect the nectar. If the nectar is to be used for sugar and not a beverage, it is placed in a shallow pan over a fire and cooked until evaporation makes it very thick. While it is still hot, the thick liquid is poured into coconut half-shells or into wooden molds to solidify. After the cakes harden, they are removed from the molds either for marketing in the local <u>pasar</u> or for storage for home use.

Small quantities of sugar cane are grown by farmers throughout the Archipelago, but only on Sumatra and Java has the author seen it utilized for processing into sugar.

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The most primitive equipment observed was in Sumatra where two-roll crushing mills made entirely of wood and operated either with man-power or animal-power were in use in 1951 and 1952. On these mills (Figure 81) above the crushing part of the rollers was a wooden support and bearing; above the bearing were two helical gears cut from the same pieces of wood as the crushing rollers and above one gear was a stub shaft to which was attached the drive pole for men or animals to apply the operating force. It is in observing the operation of these primitive mills that one gains an insight into the disregard for labor that is typical of Indonesia. The cane is fed between the rollers by one person, initially one stalk at the time; as it passes between the rollers, a second person pulls the stalk clear of the rollers and places it by the mill where the first person can reach it so that it may be fed through the rollers again. After the first pass through the rollers, two or more stalks are fed through the mill simultaneously to insure enough pressure to extract more juice. The stalks are usually passed through the mill about five times before extraction is considered complete, and the bagasse is placed in the sun to dry so that it may be used as fuel for the evaporation. The native ingenuity of the people is illustrated both in the carved helical gears and in the method of lubrication. The gears are lubricated by the simple expedient of placing an oil bearing nut the size of a pecan between the gear teeth so that the crushed nut becomes a semi-solid lubricant replenished as necessary by the insertion of another nut.

In Central and East Java the use of steel or cast iron crushing mills with two or three rollers is common, and gasoline or diesel motors up to 15 horsepower are quite commonly used. Even with these improved types of mills (Figure 82) the cane is normally fed through the rollers one or two stalks at a time and is usually returned for the second crushing, after which the bagasse is placed in the yard for drying prior to use as fuel. The pans used for evaporation are circular iron or steel pans, about thirty inches in diameter and about eight to ten inches in depth. At the Sumatra mills observed, where only one pan was used for evaporation, a basket woven of bamboo, about six inches smaller in diameter than the pan in diameter and 18 inches in height, was placed in the pan to prevent the foaming syrup from running over the side of the pan while boiling vigorously. The foaming juice boils up through the loosely woven basket, and upon cooling from exposure to the air, it runs back down the outside of the bamboo basket into the hot pan. After the juice has boiled for about four hours, a small amount of a saturated solution of lime is added to the condensed juice as a crystallization catalyst. When the juice is judged to have been evaporated sufficiently, it is poured into molds while hot or it is allowed to partially

Figure 82. Horizontal roller power driven sugar mill in East Java

Figure 83. Circular iron inserts used to prevent juice foaming out of pan

cool and is forced through a coarse screen to obtain a granulated brown sugar for the local market.

At the small processing plants using the iron or steel mills, several evaporating pans, usually six or seven, are mounted over a single furnace. The fire box is under the first two or three pans and the evaporation begins in these pans which, of course, are the hottest. As the cooking progresses, the syrup is moved away from the fire by progressive dipping and pouring to successive pans. Circular inserts of woven bamboo or of iron are placed in the three or four hottest evaporating pans to prevent the juice from boiling over; the juice boils over the top of the insert, and runs down the sides and back into the pans through the loosely woven bamboo or through perforations in the case of the iron inserts (Figure 83). In these mills one percent by volume of a saturated solution of lime is added to the juice at the time it is poured into the second pan. A number of small plants operating in East Java were using from two to twelve furnaces, each with six or seven pans, so that continuous production was achieved.

At these plants when the evaporation was completed, the crystallizing syrup was placed in man-powered agitators, a rotating bar of wood or iron with downward teeth protruding which just cleared the bottom of the pan about five feet in diameter and eight inches in depth. In the agitators observed, there were also two rows of teeth sticking upward

from the bottom of the pans which were alternately spaced with the teeth attached to the rotating bar. The hot sugar was placed in these agitators and stirred continuously until cool to prevent the formation of hard lumps and was then placed on a screen with 0.25 inch mesh (Figure 84) for the final processing.

These small mills, which are estimated to obtain a 10 percent yield from the cane processed, are inefficient when compared to the large factories of the estates which obtain measured yields of 13 percent and more. However, the present economic position of such mills is reflected in the success of the farmer near Besuki, East Java, who began with a cattle drawn mill and one furnace after the war. At the present time this particular plant has a 15-horsepower diesel motor driving a three roll, horizontal steel crushing mill, and 12 furnaces in operation. Prior to the 1953 grinding season the capapcity of the plant was to be doubled by the installation of a second motor-driven crusher and the construction of additional furnaces to make its total capacity of 1,000 pounds of sugar per hour. The owner stated that with the enlarged capacity he expected to be able to process the cane production of about 125 acres in 1953. Some of the cane was the farmer's individual crop, some was purchased from other farmers, and some cane was processed for a part of the sugar produced.

Because of the lack of storage facilities, as well as

Figure 84. Screening brown sugar in East Java

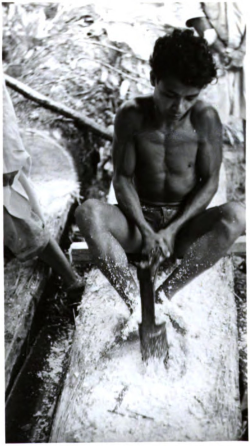

Figure 85. Sago pulp being loosened from trunk with bamboo cudgel

the lack of capital to permit farmers to hold their sugar until after the grinding season is finished, most of the brown sugar is sold directly from the mill to Chinese traders of the cities. The Chinese traders often contract for the production from the small mills and even furnish the bags or other containers for the sugar. In 1952 the price at the mill during the grinding season was 4.4 cents per pound, but it was expected that the price would advance to 8 to 10 cents per pound in the local markets after the season was finished.

F. Sago Processing

The production of sago flour has remained a very primitive process because, according to local officials in the areas where it is of importance, it has always been and even today is considered an emergency food to be used when the supply of rice is inadequate. This actually is almost a continuing emergency in the Moluccas where because of inadequate rice production and of inadequate shipping to maintain ample supplies, there seldom is enough rice for the people and away from the few small cities the situation is probably exaggerated even more.

The method of processing observed on the island of Ambon in 1952 and said by local officials to be typical was being accomplished by four men. The palm had been cut, stripped of its fronds, moved near a stream, split into two

halves and left with the flat sides of the logs up. At opposite ends of a half log two men began pounding (Figure 85) the fibrous, pulpy center of the log. The cudgel used by the men consisted of a bamboo cutting shank with a short iron handle. The bamboo was of the large variety, about four inches in diameter, and the leading edge was cut with an angle so that it struck the log with an angle between 15 and 30 degrees. The contact of the cudgel with the log produced a combination cutting and pounding action which cut the fibers and flour from the mass of the log and at the same time tended to loosen the flour from the mass in the bottom of the holes which quickly developed in the soft log. As the leading edge of the cudgel became dull, it was sharpened by cutting the blunted end of the bamboo.

The two men pounding were able to keep enough material loosened in the logs so that the third man of the group was kept busy carrying this material to the place of sieving at a stream about fifty yards distant. The sieve used in the wet sieving of sago flour is made from the heavy shank of a frond from the tree. The shank of the frond may be compared to the layered construction of an automobile tire; the woven cord of the tire is represented in the netted coarse veins of the frond, while the rubber filler and tread may be compared to the gummy substance of the leaf. The sieve is prepared by separating one ply of the netted veins and scraping the gummy material from it without

destroying the net, leaving a pliable screen of slightly smaller mesh than ordinary fly-screen. The width of the fronds near the base, the part used for the sieve, usually is at least 12 inches.

The material pounded from the logs is placed in the frond and mixed with water dipped from the stream. The frond is mounted with a slope towards the sieve and the end of the sieving section attached to a bent bamboo pole with a thong to assist the man (Figure 86) in the agitation of the material and to hold the end of the sieve high to prevent waste when the man turns loose to dip more water from the stream. The flour is half-washed, half-forced through the sieve by hand and pours over a woven bamboo screen which stops any fiber that may have been splashed over the sieve. The flour-laden water then flows into a settling basin; in the particular case observed, the settling basin was a dugout canor placed at a slight angle so that the overflow was at the far end of the canoe. Most of the flour settled out quickly, but some is of such fineness that the water is said to remain milky in color for about a week.

The log shown in Figure 85 was about 15 inches in diameter and approximately 30 feet in length. The workmen estimated that it would yield approximately five hundred pounds of flour and that approximately two weeks would be required to remove all the flour from the log. The fiber removed from the log in obtaining the flour is of such short

Figure 86. Sago flour being washed through screen made from frond

Figure 87. Farmer's rubber processing shed and equipment in Central Sumatra

length and is so coarse that it is considered worthless; it is simply thrown out on the bank of the stream or into the water with no effort for its conservation or utilization.

After the flour settles out of suspension, it is placed on woven straw mats for air drying. When partially dry, it may be cooked as previously described, or the drying may continue until the flour can be packaged for storage or for marketing. The usual storage is woven bamboo baskets lines with banana leaves.

G. Rubber Processing

The farmers' processing of rubber utilizes small quantities of relatively simple equipment. In the simplest processing method the latex is collected, poured into containers, and permitted to coagulate to form slabs with or without the benefit of coagulating agents; in the most primitive processing the containers are holes in the ground, but the rubber produced under such conditions has little value because of the poor quality which partially is the result of very slow coagulation and partially because of the presence of dirt and other foreign material. The coagulating agents normally used are alum and formic acid, but dilute solutions of sulphuric acid are also used to a lesser degree. The coagulating agents are normally purchased through trade channels, but the formic acid is sometimes obtained by crushing certain species of ants in water.

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Coagulating pans are the first major improvement adopted by the rubber producing farmers. The pans recommended as conducive to the production of the highest quality of slab rubber are made from aluminum but galvanized iron pans are also quite commonly used because they are less expensive. The pans are about four inches deep, ten inches wide and sixteen inches in length. If the farmers' processing stops with the production of slab rubber, it is sold directly or through traders to the remilling plants where the slabs are further processed to produce blanket rubber. It is profitable for the farmers to carry the processing at least one or two phases beyond the production of slab rubber.

With simple equipment the next stage of rubber processing is that of pressing the slabs into thin sheets. After the latex has coagulated into slabs, the slabs are soaked in water to obtain the desired degree of workability and the slab is then passed through rubber mangles or rollers so that it is pressed into sheets about 18 inches wide, 0.25 inch thick, and 4 feet in length. Each mangle has three cast iron or steel rollers and is hand operated. Mangles are normally used in pairs with smooth rollers on the first mangle and ribbed or corrugated rollers on the second mangle so that the finished sheets have a cross checked surface that accelerates the final drying. The simple equipment of a farm processing shed is shown in Figures 87 and 88.

Figure 88. Small rubber processing shed with aluminum coagulating pans in South Sumatra

Figure 89. Sheet rubber in open for air drying in Central Sumatra

After the rubber is pressed into sheets with the mangles, it is dried by hanging over racks in the open for five to eight days (Figure 89) or it is dried in smoke houses (Figure 90). If other factors such as cleanliness and the type of coagulating agents are equal, the smoked sheet rubber is of higher quality and consequently sells at a higher price. This difference is attributed to the disinfectant characteristics of the smoke which retards the development of fungi in the rubber. The drying time in the smoke houses varies from 24 to 48 hours, a variation sometimes due to the amount of rubber to be dried before market day.

H. Tea Processing

The processing of tea is not normally carried out by farmers but by the tea estates which not only process the production of their own tea plantations but also purchase tea from the farmers for processing. The tea produced by the farmers and sold to the estates amounts to approximately 35 percent of the total production.

When the tea is brought to the processing plant, it is placed on shallow trays in a room with controlled ventilation for sixteen to eighteen hours while it wilts and loses thirty to fifty percent of its weight from evaporation of the water from its leaves. The wilting rooms present many combinations of natural and forced ventilation depending

Figure 90. Model of improved type of rubber smoke house in Central Sumatra

Figure 91. Kerf tobacco being shredded by hand prior to sun drying

upon the availability and cost of power in the particular location. After the tea has wilted, it is placed in machines for rolling, machines which consist of a receptacle above a table with a pressure control above the receptacle, and either the receptacle, the table or, in double action machines, both the receptacle and the table have an oscillatory motion in a horizontal plane. The rolling effect is best visualized when compared with the motion of the hands when one rolls a ball of wet soil or other material between the hands. The tea is usually rolled two or three times with increasing pressure each time, and the finer tea is removed after each rolling.

From the rollers the tea goes to a roll breaker, in appearance a modified cylinder disc seed cleaner or a combination shaking sieve and fan type seed cleaner, which breaks up the balls of tea and separates some of the stems from the leaves. In this condition the leaves have been partially dried and partially crushed so that the juices of the leaves ferment in a period of 1.5 to 4.5 hours. In order to insure uniform fermenting, the tea is spread in two to three inch layers on flat trays or on the floor in rooms where the relative humidity is maintained near 100 percent.

After fermentation, the tea is passed through dryers, the most modern of these are continuous conveyor type machines, with forced draft of air maintained at approximately 200° F.

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The dryers must be controlled within very narrow limits to prevent scorching the tea as the process nears completion when the moisture content of the finished product is approximately 10 percent. The dried or rough tea is again spread so that it will cool quickly, often on endless conveyor belts to the sorting machines, which from the mechanical viewpoint are modified seed cleaners, and eventually to the final sorting by hand. A part of the hand sorting is by winnowing with the same shallow bamboo trays used for rice, and a part of it is accomplished by women seated along both sides of endless conveyor belts.

I. Tobacco Processing

There are three distinct methods of processing tobacco which are followed by Indonesian farmers. The most widespread method is for the production of kerf tobacco, the tobacco which is used in the homemade cigarettes and for pipe tobacco throughout the Archipelago and is primarily adapted to the processing of relatively small quantities of tobacco by the family for home consumption. However, the processing of kerf tobacco sometimes becomes more or less a tribal affair with several related families processing kerf tobacco for the market. The processing of krossok and Virginia type tobaccos is concentrated to a large degree in the tobacco producing area of Central and East Java.

For the processing of the kerf tobacco the leaves are

[illegible]

picked individually and hung in open sheds or more often under the protection of the roof of the farmer's house until partially dry and completely wilted and limp. Several leaves are then rolled together loosely and shredded by hand cutting. The roll of leaves is placed in the needle-eye shaped opening of a small wooden standard with one hand and is cut with a downward stroke of a knife in the other hand (Figure 91). The knife is forced downward and simultaneously slopes towards the iron faced edges of the needle-eye, and the tobacco is wedged tightly into the bottom of the eye. The tobacco is fed through the opening between cuts so that the leaves are not exposed more than about 1/16 of an inch. As the roll of leaves becomes too small to be held, the remainder of the roll is combined with additional leaves and the process continued. The shredded tobacco is spread, in no more than two-inch layers, on woven mats and placed in the sun for drying to complete the process.

The processing of the Virginia type tobacco is the same process as the flue curing of bright leaf tobacco in the southeastern part of the United States. The leaves are picked, graded, and strung on thin bamboo poles, and hung in the curing barns for drying (Figure 92). The barns are heated from wood burning furnaces from which the smoke flues extend across the floors of the barns to provide a surface for radiation. The temperatures within the barn are determined by thermometers and regulated by manually

Figure 92. Barns for flue-curing Virginia type tobacco in East Java

Figure 93. Improved type houses using bamboo for vertical siding at Anak Kamang, Sumba

controlling the drafts and the size of the fire.

The krossok tobacco is processed by air drying followed by a period of fermentation. The leaves are picked, graded, strung on poles, and hung in the thatch covered drying barns for periods of three to six weeks. The time required for drying is determined by the weather conditions, and the thatch roof provides something of a natural ventilation system. If the weather is hot and dry, the thatch material tends to curl and separate so that the hot air given off by the closely hung tobacco may rise and pass out through the roof, but in the presence of rain or very high humidity the thatch material becomes relatively limp and lies very close to form a roof that is not only water proof but also virtually air tight. When the tobacco has dried sufficiently, it is placed in containers for fermentation under close observation, but the details of this process were not available to the author.

The processing methods of the tobacco on the estates generally follow the same procedures as those used in the preparation of the krossok and the Virginia type tobaccos except that the cigar wrapper tobaccos are not fermented after air drying in the thatch covered drying barns. The estates normally produce tobacco of a higher quality because of more accurate grading and more accurate observations of conditions during the processing; this they are able to do because of the number of specialists included in the operating personnel of the estates.

J. Coffee Processing

When harvested, coffee beans are enclosed in a pulpy pericarp which must be removed prior to roasting. As the beans mature, the outer cover is variegated with a general mixture of red, yellow, and green, and although the cover may be removed by hand shelling when dry, the quality of the coffee decreases. The farmers who have no equipment for processing coffee dry the beans in the sun and shell them by hand. The poor grades of coffee produced in this manner are consumed at home, or they are sold at the nearby pasar for local consumption.

The processing of coffee for the urban or the export market requires machinery, and the actual processing requires the movement of the heavy products several times. The first stage of processing is grading by flotation; the beans are dumped into a water tank, and the heavy first grade beans are then fed through one processing line while the lighter beans of lower quality are processed separately. The beans pass through a pulper, a machine with rollers spaced closely enough together that the outer pulp is crushed but the beans remain intact, and then to rotary washers or centrifuges which by the use of approximately twice as much water, by weight, as the quantity of beans washes off the loosened pulp.

After pulping, the beans are placed in soaking tanks for about six hours where a slight degree of fermentation

occurs. After the beans have soaked, they are tramped by men walking around in the tanks and stirring the beans with their feet to further loosen the remaining outer pulp; the beans are then placed in a second tank, and the process is repeated before the excess water is drained and the beans are moved to the drying floor. The drying floor may be a concrete slab in the open for sun drying, or it may be a perforated steel floor above furnaces for accelerated artificial drying. The sun drying requires approximately two weeks and the heated floor drying only about 12 to 15 hours. It is needless to say that, because of the more accurately controlled conditions of the artificial drying, the quality of the beans is higher than for the sun dried beans.

From the drying floor the beans are placed in a conditioning room and left until the remaining moisture has become equalized. It is necessary to remove the thin inner husk which is similar to the thin inner husk of a peanut. This may be accomplished by hand, but it is a process well adapted to a cleaning machine equipped with brushes, screens, and forced air. The brushes break the thin husk; the screens not only separate the beans from the husk but also grade the beans as to size and separate the whole beans from the broken ones. The air blast also assists in the separation of the husks from the beans.

The final processing of the coffee beans is the inspection

by workers who remove beans not having the bright green color of the best quality and also the few beans to which the inner husk still clings. Although coffee may be processed almost entirely by machinery, there has been little real incentive for the establishment of efficient labor-saving processing plants because of the presence of enough cheap labor to make attention to such detail necessary. The same is true in almost every other type of processing found in the country.

CHAPTER XV

FARM STRUCTURES

A. General Conditions

Under the tropical climate of Indonesia the principal requirement of farm structures is to provide protection from the sun, wind, and rain for the people, the livestock, and those food crops which are stored for home consumption. No particular attention is necessary because of low temperatures except in the mountains, and even at high altitudes few provisions are made for heating even though enough heat to remove the chill of the humid west monsoon nights might provide more healthful living conditions. Because houses traditionally have been without heat and because the economic condition of the people is generally poor, consideration for heating facilities in the future will continue to be the exception rather than the general rule.

Structures for all purposes vary from the primitive bamboo and thatch buildings to reinforced concrete and masonry buildings. In the simplest structures there is no foundation as such, although the bamboo poles or wooden frame members may be placed on stones. More frequently, however, the bamboo poles or wooden posts are set in the ground especially on Java. In many areas outside Java, structures on log piers or piles are quite common, and here again some are placed on stones, but more often they are on the ground. The preferred type of structure for all purposes appears to be of masonry construction, and for this type of structure reinforced concrete is used for the foundations.

Bamboo is by far the most commonly used structural material of Indonesia. It is available throughout the country and is economical, it is light weight and easy to work with simple tools, and it may be used satisfactorily for either compression or tension framing members. If used where it will remain dry, bamboo will last for years, but it rots quickly when subject to alternate wetting and drying, and it is also highly susceptible to insect damage. In addition to the use of bamboo poles for framing members, the lightweight poles are used for ladders and scaffolding (Figure 57).

Bamboo is also used in other forms. For structures where appearance is unimportant the bamboo poles are partially split in several places and flattened by beating and then used as vertical siding (Figure 93). Where appearance and strength, as in grain bins, are of importance, the bamboo is split, both longitudinally and radially, into thin strips and woven into sheets seven to ten feet in width and in variable lengths up to twenty feet. The woven bamboo might well be described as pre-fabricated wall sections as it can be ordered to desired dimensions.

Lumber from many species of trees is used for almost every conceivable structural purpose. The characteristics of the different species are so varied that it is impractical to attempt any detail here more than to state that because of its strength, durability, ease of working, resistance to insect damage, and availability in the areas of greatest population density, teak is the most important structural timber. In South Kalimantan, where teak is not locally available, the use of iron wood is more common than teak.

One of the greatest disadvantages in the use of lumber for construction in Indonesia is the lack of development of the lumber industry. Hand-sawed, rough lumber in desired dimensions is available from dealers; dressed lumber ordinarily is not available. Therefore, the carpenters on the job must not only cut, fit, and erect the structure but must also dress the lumber, using hand planes and even scrapers to accomplish the laborious task. The rate of construction is further retarded by the practice of using mortise and tenon joints secured where necessary by wooden dowels. Whether or not this procedure should be attributed to the low holding strength of nails in the tropical lumber, to the price of nails ($0.20 per lb.), or to tradition is indefinite.

The American technique of cutting lumber according to a detailed plan and fastening framing or other members in place is not used. All trusses, beams, posts and other

members are cut, fitted, and assembled on the ground and while assembled are marked at the joints. When all members fit properly and are marked to permit reassembly, they are separated and assembled in the structure. This labor consuming method of construction is undoubtedly due, at least in part, to the lack of appreciation of potential labor productivity, but it must also be partially attributed to the educational level of the carpenters, few of whom can read or write and to most of whom blueprints would have little value, but the skill of the carpenters is such that if the foreman will help construct one truss or joint, they can copy is satisfactorily. The gauge rafter is marked in place by a carpenter sitting on the ridge pole who marks the top cut while another carpenter marks the plate cut; the rafter is then handed down and cut as marked and used as a gauge to mark other rafters. After the rafters are fastened, the plumb cut at the eave is sawed, guided by a taut string stretched to enable cutting them the same length; needless to say they are not sawed plumb.

The urban areas are characterized by masonry structures. The load-bearing structural members are of reinforced concrete, while non-load-bearing walls are of a porous brick. Although most of the brick are fired, the author has seen few brick of higher quality than those produced at the primitive kiln near Negara, Kalimantan (Figures 94 and 95).

Floors usually are made of pressed cement tile, but

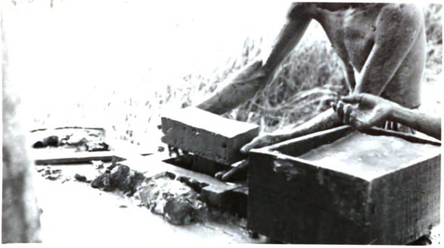

Figure 94. Removing brick from mold for firing near Negara, Kalimantan

Figure 95. Brick stacked loosely above fire-box for drying

glazed tile is used in a few business establishments and occasionally in bathrooms. Smooth pressed tile is standard for inside floors, while a grooved or pebble grained tile is preferred for porches and bathrooms where water would cause poor footing.

Reinforced concrete beams are usually poured in place by means of wooden forms, but posts are often poured by using concrete pipe as a part of the posts, as well as the form, and fastening the reinforcing steel in a vertical position within the pipe.

In masonry structures the concrete beams and brick walls are usually covered with about two inches of plaster made of lime and sand with a minimum of cement. Most of the lime used in Indonesia is domestically produced in kilns (Figure 96) located near the sea or on coral limestone formations that were formed under water and subsequently elevated. The lime is produced by charging the kiln with alternate layers of coral and wood and burning.

Another marked variation from American construction techniques is observed in the installation of plumbing and electrical systems. The procedure observed in Djakarta was said by a Dutch contractor to be standard practice. A structure is finished and then channels are cut in the floors or walls as necessary to permit installation of water pipes or electrical conduits. The channels are then recovered with the flooring tile or plastered and in the

Figure 96. Silo type coral lime kiln near Ambon with capacity of approximately thirty-six cubic feet per thirty-six hour burning period

Figure 97. Bamboo pipe showing method of making square joints

case of walls or ceilings white-washed. The contractor stated that it was impossible for him to teach the plumbers and electricians to make installations before a structure was complete.

Materials used in walls and ceilings other than plaster are lumber, asbestos boards and woven bamboo, of which the latter is by far the most common. The wall of the rural bamboo framed structure is usually of woven bamboo, the use of which is also quite common in wooden framed structures. While woven bamboo is frequently used alone in all types of buildings, it is sometimes covered with paper and then white-washed when used for walls or ceilings in masonry structures. Wall paper in Indonesia is a means to an end because the paper is almost always white-washed. The paper most commonly used is white or off-white; it is made in very thin sheets about 3.5 feet square and is usually referred to as rice paper.

Corrugated metal, zinc coated iron, and aluminum are quite commonly used as siding and roofing for processing plants, warehouses, and other industrial type structures. Although corrugated iron is used to some degree in rural structures, it is not common with the above exceptions.

Thatch and clay tile are the most common roofing materials, but wooden shingles are used in relatively restricted areas. Thatching material is obtained from a number of plants, including alang-alang and other large grasses, as well as the nipa palm, the aren palm, and the sago palm. While thatch roofing material generally is from the palm fronds, in some areas, notably the Batak Highlands of North Central Sumatra and the Minangkabau territory of West Central Sumatra, the fibrous growth from between the sheath of the palm fronds and the trunk is commonly used. This hair-like fibrous material is very coarse and seems to be dependent upon mass for its effectiveness rather than any shingling effect as most of the roofs from this material are eight to ten inches in thickness.

The thatching material is usually folded over a thin strip of bamboo on the outside and at the top of the fold. The method of fastening is to tie the clamping strips of bamboo with very small slivers of bamboo, small enough that they are flexible and may be interlaced back and forth without breaking. In this manner the thatching material is made into large shingles, three to four feet in width and one to two feet in length, for laying on bamboo rafters. The over-lap on the thatch shingles is at least 75 percent and results in thick roofs that not only provide protection from the rain but also insulation against the tropical sun.

Hand rived wooden shingles of hardwoods are used to a minor degree throughout the country, but usually there is little semblance of transition from thatch to wood to tile. Only in South Kalimantan has the author observed wooden shingles as the predominant roofing material of an area.

The roofing tile of Indonesia is generally a poorly fired, red clay tile, extremely brittle and somewhat porous. In the manufacture of the tile no provision is made for fastening the tile except for lugs to hang over the supporting strips on top of the rafters. Ridges, valleys, and hips are fixed in place with cement mortar, but the roof area remains in place through the force of gravity alone. The combined forces of thermal expansion and contraction, of stray cats, and of the wind and rain very often cause the tiles to shift enough to permit leaks, especially from the high intensity rains that are accompanied by moderate winds; high winds are virtually unknown in Indonesia.

B. Dwellings

The simplest dwelling is a bamboo frame which may or may not be covered except for the thatch roof to provide shelter from the rain. Cooking is on small charcoal pots large enough to support one frying pan or other utensil regardless of the social or financial position of the family except in a few cities where gas is available. Most of the primitive houses are enclosed by the woven bamboo material and also have an unenclosed porch area under the roof that serves as a kitchen when it rains, but often cooking is in the open.

On Java it is typical that most rural houses are without flooring. The customary practice is either to enclose the floor area with a low wall of rock or other building material and to fill this with soil to be compacted by tamping or to leave the floor area raised by excavating around it. Even in better houses the foundation is constructed so that the tile floor is raised very little above the surrounding area. Customs vary in other areas with most of the houses upon piers or piling and floored with wood or split bamboo. When split bamboo is used as flooring material, it normally is in two or more thicknesses which are laid at right angles to each other.

While one-room houses are not uncommon, most houses have two rooms or more with the size and construction material reflecting the financial and social position of the family. Typically rooms are very small and, if judged by American standards, have inadequate windows to provide light and ventilation. The latter is particularly apparent when rain makes it necessary to cook under the roof for no provision is made for smoke to escape.

In the larger homes it is customary for the main part of the house to include a sitting room, dining room, and the bedrooms. The term sitting room is used advisedly as many such rooms are only large enough for a low, circular table and four medium-sized straight chairs. The kitchen, bathroom, storage room, and servants' bedrooms are usually

in a semi-detached section of the house and are connected to the main unit by a covered walk. It is fairly general that there is enough overhang of the roofs that it is unnecessary to close windows or doors except for unusually hard, blowing rains, but the overhang is also enough in many houses to reduce the light and ventilation below a desirable minimum.

Built-in storage facilities are absent from all classes of homes, even the most expensive city homes, except for a relatively large storage room usually located next to the kitchen. Storage space for clothes, linens, and other personal or household effects is obtained through the use of cupboards and cabinets included in the furnishings of the house. While such cabinets reduce the effective size of the rooms, there is the advantage of better ventilation than would exist in built-in closets.

The so-called "dry-closets" used in some parts of the United States, as well as in many tropical areas, usually cannot be used in Indonesia for lack of electricity. Such a closet is equipped with a small electric bulb so that the heat given off will reduce the relative humidity and increase the circulation of air. Many such lights are placed on or near the floor to obtain best results and if so are protected by a screen to prevent any garmet from coming in direct contact with the bulb to prevent damage to the articles and to eliminate any fire hazard. In the rural areas of Indonesia electricity is almost completely absent, and even in the urban areas so little electricity is available that homes are usually restricted in both the number of watts that may be used at any time and the monthly consumption. Single dwelling units often are permitted no more than three to five hundred watts demand load by means of a circuit breaker and are limited to three to six hundred kilowatt hours per month.

Perhaps it is because of the absence of a reasonably well educated, reasonably well paid stratum among the Indonesian people, a stratum which finds it necessary to do most of their own work in the house and yard in order to live reasonably well, that little attention has been given to the arrangements of rooms or to the construction of labor saving facilities in the homes. It is typical that every Indonesian household headed by a salaried worker will have at least one and more often two or three servants who do most of the cooking and the laundry and look after the children. In the farm homes servants are uncommon, but because of the size and limited facilities no attention to labor saving arrangements is possible. The poorest farm homes have only woven straw mats placed on the floor for beds, no chairs or tables, two or three charcoal pots, and the same number of cooking utensils. The first indication of an improved level of living is the addition of bamboo platforms for beds and then the addition of a small table and four chairs to provide a place for the man to receive guests. The wealthier farmers have wooden or iron beds, kapok filled mattresses, mosquito nets, and other furniture which make a more comfortable living possible.

C. Water Supply and Sanitation

The rural water supply of Indonesia is either from running streams or wells; the former is the most common except in those areas where year-round streams are few in number because of the severe drouths of the east monsoon as is the case in Sulawesi and most of the Lesser Sunda Islands. Water systems are found only in the urban areas, and these are inadequate because of the phenomenal growth of the cities since the war and the lack of routine maintenance and expansion during the period from 1941 to 1950. The efforts of the division within the Ministry of Public Works and Power responsible for the installation, operation, and maintenance of public water systems have been hampered by the lack of funds in their budget.

It is safe to say that the only rural supplies of running water are the few that divert the flow of water from a spring or small stream through pipes to the farm homes. In a very few instances second-hand pipe has been salvaged from industrial and estate plants and used for this purpose, but almost all of the few systems utilize large bamboo. In some cases the internode sections of the bamboo have been knocked out with thin wooden poles, while in others the side of the bamboo have been cut out so that the internodes could be cut out with a knife. Where the internodes are knocked out, a continuous pipe is made by driving the small end of one bamboo tube into the large end of the next piece. Such joints, while inadequate for high pressure, will permit a family water supply to flow without excessive losses at the joints. When the sides of the bamboo are cut out, it is then used as an open channel and losses at the joints are prevented by using enough overlap at the joints to prevent excessive losses. In some few cases with either method the joints are caulked with mud, but these are the exception rather than the rule. While there is a degree of flexibility in the bamboo pipes for abrupt changes in direction, holes are cut in the sides of the bamboo so that other pieces may be fitted into the holes at whatever angles are necessary (Figure 97).

Even though there are a large number of bamboo pipe systems, by far the greatest majority of the Indonesian people go to the streams for bathing, for disposal of body wastes, and for their laundry. It is very common to observe bathing, brushing of teeth, washing of clothes, washing of vegetables, and defacating taking place within a few feet of each other along most of the streams, especially in the densely populated areas of Java and to a lesser degree on the other islands. Because under this system most of the normal demands of water for daily household needs are met by using the water at its source, it is necessary to carry only the small remaining requirements for cooking, dish washing, and drinking from the stream to the house by means of earthen pots, five-gallon tin cans, or other containers such as bamboo tubes, gourds, or other natural containers.

The above statements apply to the lower income group of the Indonesian population, but it should be remembered that the low income group includes by far the largest proportion of the population. The Indonesian people with better than average education who are financially able to afford the expense install bathing and sanitary facilities in their homes with the sewage from the water closet draining into a cess pool and all other waste water being disposed of by open canals. The typical indoor bathroom has a tile floor and a storage tank in one corner; there is no bathtub and seldom a shower and it is necessary for one to bathe by using a dip-bucket to pour water over himself. The dip-bucket usually is of about one-half gallon capacity and has a round wooden handle across and just below the top of the bucket. There are many outdoor bathrooms located near the wells, but the bathing procedure is the same whether in a river, an indoor, or outdoor bathroom. The outdoor bathroom usually is screened from

the public view by a wall of woven bamboo about 4.5 feet in height, shoulder high or a little more for the average sized Indonesian, and there is a half barrel or other container to store the water for bathing.

The almost universal use of boiled water, tea, or coffee for drinking probably reduced the incidence of water-borne diseases, but opinion is divided as to the probable importance of the rivers as sources of skin diseases and infections. Unless there is a natural immunity developed from the bathing twice daily that is habitual, it seems likely that accurate statistics would reveal a high incidence of skin diseases and infections attributable to the use of river water under such disreputable looking circumstances.

Wherever wells are used, it is almost universal that the water is drawn by buckets attached to a rope and drawn up hand-over-hand. Occasionally one may see a shallow well where a long lever with a bucket on one end is used (Figure 98), but the use of even pitcher-type pumps is seldom observed. Although there are many locations in Indonesia where the use of hydraulic rams would be practical, except for the difficulty of procuring pipe, officials queried about their use have never seen them used.

D. Livestock Shelter

The most common type of livestock shelter is a small

Figure 98. South Sulawesi well with pole and bucket for drawing water

Figure 99. Traditional type of Sumbanese house with cattle pen in center and platform around pen for living area

wooden pen covered with a thatch roof for the farmers' carabao, cattle, or horses, but almost without exception swine, goats, sheep, and chickens are kept in the farmyard but without shelter. More often no shelter is provided for any of the animals, and they are tied to stakes or trees in the farmyard during the night. During the day the larger animals, if not being used, are herded from one grassy spot to another by the farm boys. It is considered necessary for carabao to have access to water holes twice daily or more, and cattle and horses are also taken into the streams and washed.

In sharp contrast to the above general statement is the typical livestock shelter provided on the island of Sumba. While in other areas livestock pens, where used, are near the house, the Sumbanese house is built around the cattle pen (Figure 99). The principal part of the roof covers the cattle pen, and the human living area of the house is covered by the surrounding shed roof. The purpose of the extremely high ridge of the Sumba houses is to provide a place for the offerings to the animistic gods and spirits which are supposed to enter through the highest part of the house. It seems likely that the location of the cattle pen in the center of the house is closely related to the great value the Sumbanese people place on their livestock. On this island the social status of a family is determined by the number of livestock owned; therefore, the cattle pens were located in the place where they could be best protected from theft by raiders from other tribes at the time when most of the tribes were in an almost continual state of war with other tribes of the island.

The only improved shelter for livestock and poultry is found on the demonstration farms of the Farmers' Agricultural Service, the breeding stations of the Livestock Service, or on the few dairies in the vicinity of the major cities. The latter are stocked almost entirely with the Friesian type of dairy cattle that are kept at all times on a concrete floor in an open shed under a good roof. The dairy cattle are not grazed on open pasture but are stall-fed with the green feed being cut by hand from the terrace banks and other locations and brought to the cattle. The important major features of these improved structures are their concrete floors with adequate slopes to permit easy cleaning and their animal-safe pens which at the same time have sufficient ventilation controlled through shutters and doors to protect the animals. The use of enclosed runways for poultry and of pens for goats and sheep in an innovation that may yield results of major importance to the future of the small animal industry of Indonesia.

E. Storage Facilities

It should be apparent from previous discussion that farm storage facilities have received relatively little attention and that facilities adapted to the local conditions have been developed by trial and error rather than as the result of applied science. The subsistence type of farming that is general, together with the small size of the farms, has prevented the storage of farm products on the farm from becoming a major problem simply because the farmer never owns enough commodities at a given time for storage to be recognized as a problem of major importance. The need for attention to farm storage problems is illustrated in the report by Metcalf[1] that approximately 73 percent of the rice is harvested on Java and Madura in the four months of April through July. It is true that until the present time the need for storage on the farm even at the peak of the harvesting season has been minimized by the necessity for the farmer at the time of harvest to repay the money-lender for advances made against the crop, but it is hoped that through improved cooperative credit organizations this may be reduced in the immediate future. If, however, through the use of improved varieties of rice, by improved cultural practices, by the use of more commercial fertilizer and green manure crops, and b the extension of areas of land under cultivation and under irrigation, Indonesia shifts from a rice importing to a rice exporting country, it will

1. Metcalf, op. cit., p. 42.

mean that larger supplies of rice will be available and that farm storage will be a more important problem.

The fact that rice, cassava, and corn are harvested and dried in the open prior to storage eliminates the need for consideration for combined storage and drying facilities, but with the increased use of combines for rice harvesting that seems likely in the near future this condition will change. On the farm the rice is dried and then stored in the lumbung or grain bin in the form of padi except in North Sumatra where it is threshed and stored as padi gaba or rough rice. The grain bins usually are framed and floored with wood, the sides are from woven bamboo, and the roof is of thatch. Except in Sumatra all bins observed have been rectangular, but in Central and North Sumatra some of the bins are circular while others are inverted truncated pyramids. Figures 39 and 40 are illustrative of some of the typical bins of the different areas.

The large proportion of the rice crop that formerly moved directly into trade channels but which now moves into the direct control of the Food Supply and Distribution Foundation immediately after the harvest is also stored as padi in the warehouses and yards of the rice mills until instructions to mill the rice for the Foundation are issued to the mills. For the storage of large quantities of rice the mills use open sheds with concrete floors, and after the sheds are filled simply stack the padi (Figure 100) on the concrete floors formerly used as drying yards.

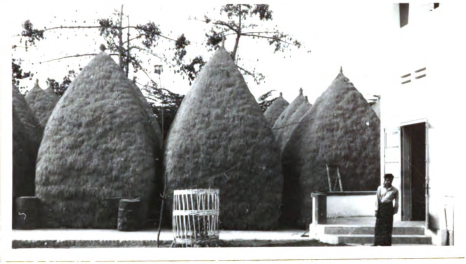

Figure 100. Padi stacked on open concrete floor for storage at East Java rice mill with kapok trees in background

Figure 101. Grain drying and storage plant constructed in Pare-Pare, Sulawesi in 1952

Corn storage is normally in the form of unhusked ears, and in the corn producing areas storage is without benefit of buildings. The ears of corn are tied with thin strips of bamboo and hung over racks or around trees (Figures 41 and 42), but the author has also been told that some corn is stored in the rice lumbungs. Only one commercial installation for the storage of corn has been observed; this plant was in Pare-Pare and will be referred to again in the next section on structures for processing.

As previously stated, cassava when stored for farm use is usually quartered, dried in the sun, and stored in a dry place. This means that the storage will either be in the rice lumbung or in the farmer's house as these are often the only structures present.

Ordinarily there is no problem of farm storage of the commercial crops; immediately after being harvested, these crops are processed and sold either in the form demanded by the trade or to industrial type processors for final processing prior to export. In many cases it would be to the farmers' advantage to have storage facilities that would permit retention of seasonal commodities to be sold in a more favorable market than exists at harvest time. The practice of holding commodities is impractical, however, not only for lack of storage facilities but also by the lack of capital for necessities or for the repayment of

crop advance. Any improvement in the storage facilities must be preceded or at least accompanied by an improvement in the rural credit system, but this does not eliminate the need for development to be undertaken whenever personnel and funds are available for such work.

F. Crop Processing Structures

The low level of farm processing of agricultural commodities is reflected in the lack of well designed and well constructed structures. Only in the case of rubber processing and tobacco curing does there appear to have been any appreciable advancement from the pole frame and thatch roof structure that serves so many of the structural requirements of the Indonesian farms.

The development of improved tobacco curing barns for both flue cured and air dried tobacco reflects the close association of the tobacco farmers with the tobacco estates. Prior to the war the estates, many of which were owned by the large tobacco companies, furnished the technical leadership for the processing of higher quality tobacco by the farmers more, perhaps, to insure adequate supplies of good tobacco for their respective companies than for the direct benefit to the farmer. Since independence this leadership has been continued under the Farmers' Agricultural Service, and the relatively high financial status of the tobacco

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farmers is reflected in their ability, either individually or cooperatively, to construct barns of their own. For air cured tobacco barns, because of their relatively large size, because of the absence of marked fire hazards, and because of the partial control of ventilation through alternate curling and flattening of the thatch material with changes in the humidity, thatched roofs over wooden or bamboo frames are preferred. Flue cured tobacco, because of the fire hazard and the required control of ventilation, is cured in masonry barns with tile roofs. Both types of barns usually have earthen floors, and there are ample racks to permit the tobacco to be hung from the roof to the floor.

In the areas where farm production of rubber is important there are many smoke houses for drying and smoking rubber. It would be misleading to imply that most of the small rubber producers own or have access to a smoke house, but in the more progressive areas there are an appreciable number, and under the leadership of the Farmers' Rubber Service additional ones are being constructed by the producers. The rubber smoke house is a rectangular structure that might be described as a 1.5 or 2.5 story structure. The wooden floors are slatted to permit the free passage of smoke from the carefully tended smoldering fires that burn in the bottom half-story of the barn. The structure is made relatively smoke tight with wooden or galvanized iron sheathing except for the ventilation stacks from the roof.

The remaining crop normally processed by farmers is sugar cane, and because of the simple requirements for the production of brown sugar, the only type of structure observed is an open shed. The best processing plants are located in wooden framed sheds with concrete floors and tile roofs, but by far the greatest percentage have earthen floors and thatch roofs. The greatest actual need at these small plants is the concrete floor to facilitate cleanliness. The usual manner of handling the juice and the raw sugar makes it impossible not to spill some of both on the floor, and it is impractical to eliminate the attraction for bees, flies, and ants, although few of the latter two have been observed in the mills.

The principal components of a modern grain drying and storage plant was completed in Pare-Pare, a city on the southwest coast of Sulawesi, in 1952. Because the export of food crops from Indonesia is prohibited at this time and even the domestic distribution of food is accomplished under the supervision and licensing of the Food Distribution Foundation, this privately owned plant may find it difficult to obtain enough grain for processing and storage to be profitable. Because this area of Sulawesi has the reputation of normally producing a relatively large surplus of corn and a small surplus of rice above the needs of the area, the plant is strategically located to permit the processing of

the surplus grains for shipment throughout the Archipelago through the favorable harbor facilities of Pare-Pare.

The plant (Figure 101) has two column type dryers, each with a capacity of 12 tons of grain per hour. The heated air from the oil furnace is circulated by electric fans powered by the diesel-driven electric generator which also provides the power for the grain conveyors. The laboratory of the plant seemed to be adequately equipped with apparatus for moisture content determinations, as well as with other scientific equipment and instruments necessary for quality control. Initial storage facilities constructed provided space for 9,000 tons of bagged grains, but the construction of as many as 15 elevators 32.5 feet in diameter and about 110 feet in height will be undertaken as the business develops and government permits such construction. In the first three months' operation of the plant in 1952, only 500 tons of grain, principally corn but including some rice, were dried and bagged; thus, it seems unlikely that the elevators will be needed in the near future especially when the general security conditions of the area are such that materially increased production is unlikely.

CHAPTER XVI

AGRICULTURAL ENGINEERING IN THE FUTURE DEVELOPMENT OF INDONESIAN AGRICULTURE

A. General Situation

Many of the specific conditions of Indonesian agriculture have been previously described; however, from the overall picture the agricultural situation may be divided and referred to in two general categories, but unfortunately the solutions of the problems of both categories must be attempted simultaneously. If the insufficient personnel available could devote themselves to the solution of the urgent need for immediate improvement in the general agricultural economy of the nation, especially as it pertains to food production, or to the long-range need for major advances in all phases of agriculture throughout the Archipelago, such concentrated attention would simplify, to some degree, the appalling problems which confront the agricultural officials of the Government.

Because the people had lived under colonial rule for so long, they falsely believed that with sovereignty their economic conditions would be miraculously improved. Such beliefs were, perhaps, encouraged by some of the leaders in the struggle for independence; and now the Government is faced with an increasing number of requests and in some

cases demands for more provincial autonomy; in some instances concessions are being made. While some decentralization might have considerable merit, the pros and cons of such a debate are beyond the scope of this study except for the observation that, if the present form of government is to remain stable, the dissenting voices of the distant areas can best be quieted by evidence of concrete benefits to the people from the programs of the Government. The benefit which would be most quickly noted by the people and would have the greatest general stabilizing effect would be a slight general improvement in the fields of food production and in some areas of land tenure conditions.

Quick, major improvement in the agricultural situation is very difficult, if not impossible, because of the inadequate numbers of technical personnel, because of the present level of technological advancement, and because of the present economic and educational level of the farmers. However, unless some improvements in agriculture, as well as in other important economic fields, can be made in the immediate future, it is likely that the populatiry of the leaders who came into prominence with the wave of nationalistic fervor that gained the nation its sovereignty will wane, only to be replaced by others likely to be far less democratic in their political ideologies.

The pessimistic views which might be drawn from the above statements should be modified to a considerable degree

because a number of methods of improving Indonesian agriculture are known to the agricultural leaders and various programs are in progress to encourage farmers to adopt relatively improved practices. It should be kept in mind also that a very slight improvement in cultural practices over large areas will be of major importance, especially when the average yields of rice and corn are so low. The average rice yield is only 500 to 500 pounds of milled rice per acre; the average yield of corn is only seven to eight bushels per acre; any of several practices could materially increase these yields.

Provided the world remains at peace and the urgent problem of immediate, slight improvement in its agricultural and its general economic situations is solved at least partially in the most critical areas, then the Indonesian Government will be stable enough to undertake the problem of long-term improvement of its rural economy. The work of solving the long-term problem must be initiated by the present generation for the future generations of Indonesia. It is impossible for any people to establish an educational system adequate to provide personnel trained at either the professional or the skilled laborer level in a short time, especially with so few qualified men to initiate such training. For example, for its pre-war population of approximately seventy million people there were two agricultural high schools, approximately equivalent to the American junior agricultural college, and the only agricultural college had not been in operation long enough for anyone to complete its curriculum. The degree of progress is best shown by comparing the 241 graduates from all Indonesian high schools in 1941 with the estimated 180 who are graduating from the six agricultural high schools alone in 1953.

B. Potential Benefits from Improved Engineering Applications

It is impossible to say what the real potential benefit of improved engineering applications to the Indonesian economy and specifically to the agricultural economy can amount to. There are many possibilities for the improvement and extension of existing irrigation systems, and irrigation by pumping from ground water supplies remains virtually untouched. While additional irrigation will contribute directly to increased food production, the increased producitivity of labor possible through the use of improved implements and through the use of mechanical power and machinery will contribute to increased food production, both directly and indirectly. The utilization of improved engineering techniques for land development will also contribute directly to increased food production through the clearing of new areas for cultivation, through increased production from controlled drainage, and directly through the establishment of erosion control practices to permit production to be sustained at high levels.

The utilization of improved engineering techniques for processing farm products may not actually increase production of the basic commodities, but the effective yield for use or for market may be increased. It is likely that the greatest benefit from improved applications of engineering in farm crop processing may result from the enhanced value of the higher quality of the finished product and from the saving of labor that must be utilized for other productive purposes to be a real benefit. Improved techniques of processing farm products for home consumption may well be derived from the elimination of many of the onerous chores which serve to make farm life unattractive and cause many of the more capable young people to seek urban employment.

Material improvement in the engineering applications involved in farm structures, except as they directly affect crop processing, farm utilities, and rural electrification, may be expected to progress very slowly. Here again the greatest benefit to agriculture will be the indirect benefits of more healthful surroundings for the farmers and the reduction of the differential between urban and rural living conditions which would retain more of the most capable youth on the farm.

In Table IV the total estimated area planted in dry rice, corn, and cassava is 14,155,000 acres with an additional 2,195,000 acres in sweet potatoes, peanuts, and soybeans as compared with 13,280,000 acres in irrigated rice. Comparison

of the production figures of Table IV bears out the general statement often heard in Indonesia that irrigated rice yields are approximately double those of dry rice and it is almost sacriligious for the Indonesian farmer to plant crops other than rice on areas that may be irrigated. In other words, the extension of areas under irrigation will increase the area planted in rice and will double the producitivity of such land. How much of the land now in supplementary food crops can be economically irrigated is not known, but from the above statistics it is apparent that the present rice deficit of Indonesia could be overcome if 3,500,000 acres already in cultivation could be irrigated only during the wet monsoon or if 1,750,000 could be irrigated to permit the production of two crops annually. Tables VII and VIII show the irrigation now under construction by the Irrigation Division, Ministry of Public Works and Power to be 115,200 acres and the proposed future construction to be 1,613,800 acres; how much of these areas are for land now under construction is not available.

Except for the East Java pumping plant referred to in Chapter XII, the thirty 10 and 15 horsepower pumps purchased in 1951 with grant-aid funds from the Economic Cooperation Administration and the fifty 15 horsepower pumps purchased in 1952, there are few pumps available for irrigation in Indonesia and most of these are yet to be installed. The possible contribution of pumps towards overcoming the food

deficit is apparent from the installation of one 15 horsepower pump near Tuban, East Java, which with its 600 gallon per minute capacity provided the water in 1952 to irrigate 500 acres of corn during the dry monsoon, corn that without irrigation would not have been planted or would have yielded less than one hundred tons. Instead this crop was estimated to have a potential yield of almost two hundred tons for one crop. Under Indonesian climatic conditions two crops per year are possible provided there is assurance of sufficient water so that a conservative estimate of the potential increase of food production per pump can be placed at two hundred tons per pump or the present food shortage may be overcome through the installation of about 4,000 pumps of comparable size and efficiency. It is impractical to recommend that such a large number be installed immediately because of the lack of qualified personnel to select installation sites, to prepare the installation designs, to make the installations, and to operate and maintain the pumps and motors even though the 4,000 complete installations should cost less than 25 percent of the current annual expenditure of foreign exchange for rice. It is extremely doubtful whether 4,000 sites for the economical installation and operation of pumps could be located, but it would be relatively easy to select suitable sites for several hundred pumps, particularly in East Java, South Sulawesi, and the Lesser Sunda Islands.

The increased use of mechanical power and machinery may contribute directly to increased food production by opening new lands for cultivation by the farmers who may still be using traditional cultural methods. It will also indirectly increase food production by decreasing labor requirements for land preparation and enable more productive use of available labor. Approximately 400 man-hours per acre are required to prepare land in alang-alang before planting rice. Better land preparation can be accomplished under the same conditions in four hours with a medium-sized tractor; if an efficient machinery operation program can be developed in the sparsely populated areas where there is plenty of additional land to be cultivated, the labor saved for the farmer can be utilized far more effectively for the cultivation of larger areas. There are those who believe that the present inefficient method of rice harvesting will continue to limit the areas that the farmer can care for, but when the farmers can cultivate larger areas than they can harvest with the ani-ani knife, they will begin using the sickle or some other relatively improved implement to permit faster harvesting.

The availability of mechanical power and machinery for land preparation in the areas where dry farming dominates will also indirectly increase food production by enabling the farmers to adopt better farming practices, particularly the increased utilization of green manure crops. It is almost impossible to satisfactorily incorporate the volume of green manure crops which will grow under the favorable climatic conditions of Indonesia by means of the primitive plows and harrows that are used with animal power. If the farmers could depend upon mechanical power for turning under the green manure crops, it would be far easier for the agricultural leaders to convince the farmers that they should use this practice which experiments and demonstrations have shown to increase yields by as much as 50 percent but which farmers are reticent to adopt because of the amount of additional work involved in the land preparation.

The above statements should not be interpreted to mean that the typical agriculture of the small, indigenous farmer should be mechanized; on the contrary, any real effort at complete mechanization should be discouraged, especially on most of Java where the size of the fields will make it uneconomical for machinery to be generally used for many years. However, in the Outer Provinces where dry farming of larger areas is typical, the increased use of tractors and machinery -- either through equipment pools individually for hire, by cooperatives, or by the Government -- can be of material benefit to the establishment of sedentary agriculture at a much higher level than one is able to see at this time. Of the three possibilities it seems likely that, because of the communal traditions of the Indonesian people and the need for many small units of equipment, the community

cooperatives have the greatest possibility for a broad general contribution to the welfare of the nation.

The application of improved engineering techniques in the processing of farm products is needed first in the processing of the farmers' commodities for the market. The most outstanding example of this need at the present time is in the farmers' rubber production which, because of poor equipment for processing and handling, poor techniques, and carelessness, is of the lowest grades that in 1952 and 1953 became a drug on the market. Some improvement in rubber processing has been previously referred to, but in general the quality of the rubber produced by the farmers is very low. Improvement in rubber processing is being encouraged, and some progress is being made with indications in this field also that the greatest improvements will be made through the cooperatives which maintain the processing sheds and smoke-houses at convenient community locations.

Although improvement of farmers' processing is more important to the economic condition of Indonesia than rice, particularly as it is related to the earnings of foreign exchange, processing for home consumption offers a far greater opportunity for labor saving through the introduction of improved techniques. The greatest needs in processing rice for home consumption are not for techniques and equipment that will result in a more highly polished rice but for those that will reduce the inestimable labor requirements of

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Work has already been undertaken towards the improvement of equipment and plant layouts for the farmers' sugar processing, but here, as in many other fields, the personnel working in the research and development program are qualified by experience in sugar processing rather than by the technical training in power and machinery and in sugar processing that would be desirable. The present work is being conducted with inadequate facilities for the fabrication of machines and with insufficient personnel for the problems involved.

The processing of other farmers' products such as copra, coconut oil, and sago flour have received little benefit of modern technology, and any improvement that has developed in specific locations may be attributed to the ingenuity of the particular owners or operators directly concerned. In the processing of these and other products either for home consumption or for the market, the adoption of some additional simple machinery, the rearrangement of processing plants to provide for an orderly flow of material, and in some cases minor changes in equipment now in use would reduce the present cost of processing so that the market price could be lowered, would improve the quality of the finished product without increasing the cost of processing, or in the case of processing entirely for home consumption would reduce the amount of labor required so that additional labor would be available for other productive effort.

Illustrative of some of the improvements which might be made in processing techniques are the following examples. The production of coconut oil at the primitive factory described in Chapter XIV represents relatively efficient production of a commodity used in every Indonesian home, most of which in the rural areas is produced by hand grating the coconuts, hand squeezing the oil from the meat, and cooking on charcoal pots. If the basic plans of this plant could be improved slightly and similar plants constructed in thousands of villages for the cooperative use of the farmers, the labor required for the production of the basic commodity would be reduced. The elevation of the drum in which the oil is cooked and the addition of a spigot through which the cooked oil could be drawn from the drum would prevent waste and improve the sanitary conditions of the plant. If the spigot were a two-way spigot, it would enable continuous bottling directly from the cooking vessel. A further improvement that could be inexpensively fabricated would be the addition of a simple steam oven to permit the

sterilization of bottles or other containers. In the particular plant referred to, there were two furnaces with a single drum mounted over each for cooking the oil; if only one furnace were used with two or more cooking vessels and the steam oven, a greater economy of fuel would be obtained.

Of less importance than the production of coconut oil to the Indonesian people as a whole but of major importance to the inhabitants of the Moluccas and to the islands off the southwest coast of Sumatra is the processing of sago flour described in Chapter XIV. The loosening of the pulp of the sago log by use of the cudgel is the part of the process which requires the most labor. If the relatively inexpensive hammer-mill could be utilized for pulverizing the log, the work which now required the labor of two men for two weeks could be accomplished in a day or perhaps less time. The labor of the two men would be partially utilized in cutting the log in small enough pieces to be fed into the hammer-mill, but the resultant saving in labor should reduce the market value of sago flour to more nearly equal its real food value rather than the relatively high price now imperative because of its high labor requirement and possible because of the deficiency of other foods in the areas where sago is of importance. Further study might also prove that the sago flour could be wet-sieved through a rotary screen with a manually operated brush inside to prevent the screen openings from becoming clogged. If a small amount of research work should indicate the feasibility of the use of the hammer-mill as referred to above, it could easily be mounted in a trailer or even in a small boat so that it could be moved from point to point and island to island within the areas where sago is of importance.

In the above observations the fact must not be overlooked that the introduction of improved machinery and techniques, in addition to improving the quality of the finished product, will increase the productivity of labor. In effect more labor will be available, and this additional labor must be directed into other productive work if the maximum benefit to the agricultural economy is to be obtained. Labor saving in Indonesia, where the availalbe labor supply is so great, cannot be considered the main objective of technological advancement; the main objective must be to enable the farmer to utilize his labor more effectively so that he may produce more by extensive agriculture in the Outer Provinces and by more intensive culture on Java and Madura.

C. Factors Affecting the Improved Applications of Engineering

While there can be no question of the great need for the improvement of the engineering applications in Indonesian agriculture, as well as for all of the other agricultural sciences, to blindly recommend that such improvements should be made immediately and to expect favorable results is wishful thinking. There are factors which favor the improved applications of engineering and other sciences; simultaneously, there are as many or more factors which deter any improvement.

1. Factors Favoring Improvement

Increased food production is of utmost importance to Indonesia because of its social, economic, and political importance. As previously stated and implied, the economic and political stability of the nation is so closely related to the status of its food supply that improvement in the applications of all sciences related to increased food production and better distribution must be accelerated if other Government programs are to have any opportunity of success.

The improvement of agriculture in the sparsely populated regions through improved applications of engineering and other sciences is necessary. In quickly and economically opening of the new areas, applications of engineering will be of greater importance than the other sciences which will come into their own after the land is cleared and irrigation or drainage systems are complete. The improvement of agriculture in these areas will contribute to the solution of

the demographic problem of Java and particular areas of other islands and will contribute to the improvement of the internal and external conditions and of the communications systems. In fact, the improvement of agriculture can make little progress in many areas unless the communications are improved; however, the improvement of agriculture will make it economical to improve the communications routes in order to take care of the increased flow of commerce to the areas where there are no commodities for market and no demand for consumer goods.

At the present time the average Indonesian diet is inadequate to permit the people to perform hard work except for short periods of time. Contributing to this factor of low labor productivity are the traditional diseases of malaria, diarrhea, dengue fever, and others which are endemic and are accentuated by the low protein diet that provides little strength for warding off illness. There is a real need for the general improvement in the dietary level, as well as in the conditions of sanitation, to improve the health of the nation -- a need which favors the improvement of engineering applications and other sciences related to health conditions.

Because the economy of Indonesia is basically dependent at this time upon the export of raw material - a large percentage of which are agricultural commodities - and the import of manufactured goods, the quality of the agricultural

commodities must be continuously improved if they are to maintain or to improve their position in the world market. There is limited prospect for material change in this overall economic pattern in the immediate future; the basic industries of power and communications must be developed before appreciable industrial development can occur.

2. Factors Deterring Improvement

The most serious deterring factor is the general educational level of the people. In spite of the bold mass-education program of the Ministry of Education to reduce illiteracy, the shortage of qualified personnel in all fields retards the conduct of programs for general improvement and simultaneously retards the acceptance of those programs which the Government is able to implement with its limited personnel. It is very difficult to find the minimum qualified personnel to conduct relatively simple courses in improved machinery and techniques.

Closely related to the deterrent aspect of the educational level of the people are the traditional customs of the people originating from adat and from religion. In some cases adat and religion are so closely related or intermixed that it is difficult to differentiate between them. The lack of differentiation in some areas makes the adoption of new implements or practices more difficult, for the leaders must not only prove the economic value of recommended practices but must also overcome the objection to change from present practices whether they be from adat only or from adat and religion; if the latter, then the introduction of new practices is even more difficult.

Of importance also as a factor which retard the adoption of improved engineering implements and techniques which would increase the productivity of labor is the lack of industrialization which would absorb labor saved through the use of improved methods. Because of this lack people who leave the rural areas only complicate the social problems of the urban areas where there is insufficient employment. Even with industrialization the migration of labor from rural to urban areas would create a problem because the lack of education would force the migrants to join the unskilled laborers only. There is little incentive, and in fact little reason, to save labor through the use of implements and techniques which cannot be utilized for other productive purposes, especially when such implements or techniques require a large capital investment for the same gross production and only provide more leisure.

It is probable that what might be described as the lethargy of the people may be the most difficult factor to overcome in the efficient utilization of improved techniques and equipment. It will be worse than useless to utilize tractors and machinery for the preparation of land in less than 5 percent of the time required to do the same

work with a hoe if the additional labor made available is not used for the cultivation of larger areas of land. It is foolish to utilize motorized fishing vessels which can catch three to five times as many fish per day if the motorized boats are used for fishing for one day and then lie in port for three to five days. Similarly, the use of pumps for supplemental irrigation will be uneconomical if their installation is unnecessarily expensive or is inefficient. Examples of each of the above fallacious uses of improved equipment and techniques may be found in Indonesia, and if they are studied with the purpose of analyzing the operation data available from them for future guidance, the relatively small amounts of money invested in them may save many times their cost in the future, but unless such information is studied objectively, then they will only serve as an example of how the limited foreign exchange may be inefficiently used. Typical of the problems that will cause some difficulty are the tendency of educated or trained personnel to think they should have uneducated assistants to do any manual labor necessary and the lack of acceptance of technically qualified personnel between provinces.

A part of the above difficulties may be traced to a residual effect of the barter economy which formerly existed throughout the islands and which still exists in some of the remote, isolated areas. Under the barter economy the pride of ownership developed because ownership, particularly of

livestock, was a visible evidence of wealth which enhanced the social position of the owner. Under this economy ownership of livestock became the objective and not the means to an end common in American where the ownership of livestock has been based either upon their value as meat or for their capability of field work for the production of commodities which could be sold. To a limited degree this concept of ownership is being carried over into present activities with tractors and machinery replacing livestock as the ownership objective with the result that the preference is for the largest tractors and machines whether they are the best adapted to local conditions or not. The fact that mechanical equipment is an item of expense whether it is used or not and the economy of utilizing mechanical equipment the maximum number of hours possible are concepts not yet fully understood. A contributing factor to this lack of realization of the cost of idle machinery may be attributed to the operations of the estates. Many of the estates have kept machinery on hand in order to insure the timeliness of some operations; because of the very favorable conditions under which they formerly operated, they were able to do so profitably because of the high values of the commodities produced. The usual work week from 7 until 2 o'clock from Monday through Thursday, from 7 until 11:30 on Friday, and from 7 until 1 o'clock on Saturday will hinder prompt acceptance of the full time operation of machinery necessary for economical utilization.

The conditions of internal and external security were shown above as a factor favoring improved applications of engineering in agriculture. From the national viewpoint the need for the improvement of the lesser developed areas is certainly a favorable factor, but at the local level the insecurity is definitely a retarding factor. At the present time it is doubtful whether machinery can be operated in areas as planned in South Sulawesi at the time the equipment was purchased because of the insecurity in that particular area. If the equipment is sent to this area, it may be destroyed or confiscated by the dissident forces, or it may be unsafe for the operating and maintainance personnel to live and work in this area.

The conflicting factors above should make it apparent that there will be no quick, easy solutions to the improvement of Indonesian agricultural engineering but at the same time should indicate the possibility of much improvement if the Government can become more stable.

D. Primary Agencies Concerned with Improvement of Engineering Practices

1. Government Agencies

a. Ministry of Agriculture. The Farmers' Agricultural Service is not only the largest organization within the Ministry of Agriculture but is also the organization which has the most direct contact with the largest portion of the

rural population. The general division of this Service is responsible for the dissemination of information that will improve general agricultural conditions throughout the Archipelago and therefore becomes the principal agency through which the people can obtain information about improved applications of engineering as well as all other agricultural sciences. At the present time this agency cannot efficiently perform its function as it pertains to engineering because of its lack of trained personnel.

The primary objective of the Mechanization Division is the opening of new land to be cultivated by the farmers using traditional cultural practices; therefore this Division is primarily concerned with the improved applications of farm power and machinery and land development at this time. It seems likely that in the future the scope of responsibilities of this Division will be expanded so that it will become roughly the equivalent of the Division of Agricultural Engineering of the Bureau of Plant Industry, Soils, and Agricultural Engineering of the United States Department of Agriculture. The rate of expansion of the scope of responsibility for this Division will be regulated by the availability of qualified personnel and for some time will be limited to power and machinery and to land development because the program already underway in these two fields exceeds the personnel capabilities for efficient operation for some time to come.

The Division of Research and Development of Farmers' Sugar is working for the development of improved small machinery and techniques for the production of raw sugar by the farmers. This Division is concerned with power and machinery and with sugar processing. It seems desirable in the future that the activities of this Division be more closely coordinated with the activities of the Mechanization Division or even combined with this Division and be expanded to include development or adaptation of small equipment for the processing of all farm products that may be economical for small farmers or for village cooperatives.

The Commercial Crops Division of the Farmers' Agricultural Service is primarily concerned with the dissemination of information pertaining to the production and processing of export crops by small farmers. This Division, while it must be interesting in processing, could well retain the dissemination of information as its primary function and receive its special subject matter pertaining to engineering applications from other agencies.

The Horticultural Division of the Farmers' Agricultural Service has its primary interest in engineering applications in the use of spraying or dusting equipment in the control of insects and diseases in fruit and vegetable production and in the use of special equipment for the conserving and processing of food. The engineering phases of the research work of the Division in production and processing at its

experiment station should be closely coordinated with the present Divisions of Mechanization and Farmers' Sugar.

The Training Division of the Farmers' Agricultural Service is responsible for the establishment and conduct of all in-service training courses for the Service. This Division must therefore be concerned with the establishment of special training courses for Service personnel in order to give them the minimum essential knowledge pertaining to engineering applications to enable them to efficiently perform their general extension functions.

The Farmers' Rubber Service finds itself concerned with engineering applications in the field of farm structures in its efforts to improve the types of smoke houses used in the curing of rubber. It finds itself concerned with simple machinery for the improvement of the techniques of farmers' processing of rubber.

The Bureau of Land Utilization is responsible for the development of a land use program to be implemented by the various Services. In arriving at a well coordinated program the applications of engineering involved will be the control of runoff from cultivated areas through the use of mechanical structures as well as through the use of erosion resisting plants and grasses, the drainage of land that would otherwise be of no value but which with drainage will not only be productive but will also permit sloping lands to be used more wisely, and the effective utilization of surface and ground

water supplies for the irrigation of areas especially where production is handicapped by severe dry seasons of long duration.

The Central Agricultural Experiment Station with its branch stations is responsible for research of importance in all fields of agriculture. To date the Station has devoted little attention to agricultural engineering, and there is no department as such, although some of the departments have indirectly collected and analyzed some engineering data of importance. In the future there is a need for more attention to all aspects of agricultural engineering which should result in the establishment of a department in the experiment station organization when there are qualified personnel to be assigned to the department.

The Government Agricultural Estates as a Government owned corporation is concerned with a larger variety of specific applications of agricultural engineering at this time than any other Government agency. This organization at the present time is engaged in every possible phase of agricultural activity from land clearing, land drainage development, irrigation, production of a variety of crops to the processing of the crops to various degrees for export or for the domestic market. In addition to its present actual operations this agency is preparing plans for the exploitation of the forest reserves of some areas for the production of additional naval stores products and also for the

establishment of a paper manufacturing industry utilizing available pulpwood from the pine forests of North Sumatra. In the present operations of the estates, agricultural engineering is of recognized importance, and this science will be of even greater importance in the successful future operations of the Corporation.

b. Ministry of Public Works and Power. Two divisions of the Ministry of Public Works and Power are directly concerned with phases of agricultural engineering. The Division of Irrigation, while primarily concerned with the large irrigation structures which may properly be classified in either hydraulic or civil engineering, is also concerned with the overlapping areas of primary and secondary distribution canals and surveys and designs for tertiary systems. In 1952 the Irrigation Division was given the additional responsibility for the installation of pumps furnished for supplemental irrigation through grant-aid of the Economic Cooperation Administration in 1951 and pumps purchased from the budget of the Ministry of Agriculture in 1952, a function that has not been satisfactorily performed because of a lack of personnel and other difficulties encountered. In the areas of overlapping responsibility there generally is a high degree of mutual respect and cooperation between the representatives of the field workers of the Irrigation Division and those of the Farmers'

Agricultural Service which promises the possibility of mutual assistance in the future which should be helpful to both organizations.

The Division of Power is responsible for the establishment and maintenance of generating plants and distribution systems. Because there had been little development in power generation prior to the war, because most of the generating plants were of the run-of-the-river type, and because between 1940 and 1950 the population of the urban areas increased by four times or more, this Division has been faced with demands of such magnitude in the urban areas alone that the rural areas have not yet received appreciable consideration in any plans for the distribution of electricity. Most of the post-war generating plants have been of the diesel powered type which while they may be installed more quickly and at less initial expense will be more expensive in the long run than hydro-electric or steam generating plants which are feasible in most areas. The generation of sufficient electric power to permit distribution to the rural areas of Indonesia is still some years in the future, but plans for the efficient utilization should be made as soon as avilable personnel will permit.

c. Ministry of Economic Affairs. Two divisions of the Ministry of Economic Affairs are concerned with applications of agricultural engineering. The first is one of the regular divisions, the Small Industry Division, while the second is

of an emergency or temporary nature. The latter, the Food Distribution Foundation, is responsible for the purchase of food supplies either from local surplus areas or from abroad and for the storage and distribution of these supplies to prevent shortages and to control prices in food deficient areas. The distribution and sale of Government owned food supplies at fixed prices has usually regulated the free market price of rice so that there is no particular advantage in purchasing from the Government owned stock, but occasionally the rice price becomes exhorbitant in isolated areas because of the difficulties of transportation. Because the Foundation owns large stocks of rice, corn, and other staple foods held in storage by rice millers and others until milled and distributed on orders from or with consent of the Foundation, the Foundation is concerned with storage and milling problems. The Foundation actually is faced with the problem of pilferage and loss of more rice by theft in some areas than by the problems of storage and milling so that any attention given to these problems has been of secondary importance. When the acute food production and distribution problem of the nation is overcome, this Foundation is supposed to be abolished.

The Small Industries Division is concerned with the development of small, indigenous industries not only for the processing of agricultural commodities for domestic consumption

and for export but also has a program for the development of all types of small indigenous industries and is especially concerned with those which will produce consumer commodities now imported. The program of this Division includes some technical assistance to small industries, assistance in obtaining foreign exchange licenses for the purchase of essential equipment, and loans to worthy enterprises which are unable to continue or to expand without credit otherwise unobtainable. Because many of the small industries are processing agricultural commodities, this Division is concerned with agricultural engineering applications in its relations with many of the small industries.

e. Ministry of Social Affairs. The primary agency of this Ministry concerned with agricultural engineering is the Transmigration Service which is responsible for the selection of areas for agricultural development, the preparation of lands for the arrival of settlers, the selection and transfer of settlers from their former homes, and assistance to the settlers while they establish a sedentary agriculture in the various project areas. In its activities the Service is concerned with problems in land development, power and machinery, rural sanitation and water supply, farm structures, and processing or storing farm products. Unless due attention is given to the applications of engineering involved, the transmigration projects will be confronted with many unnecessary problems and with probable failure.

2. Private Enterprise

The general nature of the Indonesian Government is socialistic, in that there is the concept that the Government should render almost every conceivable service for the people in almost every field of endeavor. In spite of this general attitude on the part of the Government there are still ample opportunities for the old private enterprises to continue their activities and for new privately owned enterprises to develop, although perhaps far less profitably than under the Netherlands Indies Government. Because of the need for the foreign exchange earned by the agricultural estates, it is beneficial to the Government to permit these companies to continue. There are other areas of activity in which the Government has been unable to replace private industry and such industries continue to operate. It is impossible to predict what the attitude of the Government will be towards such enterprises when the Government can employ enough qualified personnel to nationalize these industries or to purchase them from foreign owners for resale to new owners with Indonesian citizenship.

a. Production and Processing Corporations. Most of the agricultural estates are on Government owned lands leased to corporations. These corporations are engaged in all phases of agricultural operations from the clearing of lands through the processing necessary to prepare their products for the export markets. Every phase of agricultural engineering is

found in the operations of the large estates, most of which have Dutch educated personnel for the supervision of their operations. The degree of efficiency found in the applications of engineering are variable and depends largely upon the aptitude of the Dutch agricultural scientists who are in the majority on estate staffs but are usually not engineers. The efficiency is to a degree also related to the proximity of the estate to the technical services of the large importing firms, for even though most of the firms maintain technical staffs they are unable to adequately serve the estates in remote areas because of transportation difficulties.

b. Sales and Services Agencies. As mentioned above, each import-export company nominally maintains a staff of technically trained personnel which includes engineers of the various fields of specialization; primarily mechanical, civil, and electrical engineers are found and too often these engineers have no farm experience to assist in the applications of their fields of specialization. The various import-export companies, both the old foreign owned and the new Indonesian owned companies, are representatives for manufacturers whose products cover every possible need of Indonesian agriculture whether it be large or small. The manufacturers represented include practically every American manufacturer who produces for the export market, as well as the Europen manufacturers. Too often, however, the

representation is of the mail order variety with the representative willing to assist a potential purchaser in ordering every item in the company's catalog whether it can be economically used or not. The local representative has often never seen a particular piece of equipment and is incapable of advising as to its limitations or its capabilities. At one so-called demonstration of garden tractors the representative giving the demonstration freely admitted that it was the first time he had ever seen the tractor and its attachments in operation.

In those companies which handle processing equipment the personnel are generally better qualified than the above example, but in field power and machinery the representation leaves much to be desired. Some of the principal machinery companies are taking measures to remedy this situation, but it has been a source of costly errors to the Indonesian Government in the past when the Government was the principal customer of all of the importing companies and the Government officials contracting for commodities were inexperienced also.

c. <u>Contractors</u>. At the present time there is a vast amount of construction underway in Indonesia, and if there were many times the present number of contracting firms, all of them could still obtain all of the business they could undertake. There is a real opportunity here for some of the large international engineering construction firms to enter into various contracts which would be profitable to the companies and at the same time would be of dual benefit to Indonesia. Such contracts, while basically for the completion of specific jobs, would necessarily require the training of large numbers of Indonesian laborers to become a class of skilled workers familiar with modern machinery and techniques.

Without reference to any particular projects there are the opportunities in Indonesia for the following types of contracts either at the present time or in the near future: processing plants for agricultural commodities of all types produced for the export trade, dual purpose irrigation and hydro-electric installations, paper manufacture, chemical industry plants for the processing of domestic resources, and land development. The latter type of contract may well include land clearing, land drainage, irrigation, and rural road construction, as well as the development of water supply systems for the villages to be established in the areas of new developments.

E. Educational and Research Needs in Agricultural Engineering

1. Special Training Courses

The most urgent need for education in agricultural engineering in Indonesia is for a large number of short courses covering particular phases of the science, especially those where sufficient training may be given to field personnel for them to satisfactorily carry out the necessary principles in their work, whether or not they understand the principles involved. The programs which the Government is now attempting to implement will be benefited more in the immediate future through having a relatively large number of men with limited, specialized training than to wait the two to three years that would be required to send men abroad for complete training. In addition to the elements of time and need there is the availability of personnel that must be considered; there are more available, qualified men who will benefit from short specialized training courses than there are those who could benefit from longer training covering all phases of the science. Such training courses will be conducted for personnel of the Ministry of Agriculture whose field duties make it desirable for them to have particular training and later will be opened to personnel from other Ministries and from private enterprise where applicable. At the present time such a course is being conducted for the operation and preventive maintenance of tractors and machinery; a course is planned for simple surveying with reference to irrigation ditches, erosion control, and the installation of pumps for supplemental irrigation.

While it is possible to conduct some short course training within Indonesia, it is desirable that limited personnel be sent abroad for better training than can be

given here. A few men have already been sent abroad for such training and more are to be sent in the future.

2. Agricultural High School Training

As has been previously referred to, the theoretical training that is given in the agricultural high schools of Indonesia is approximately equivalent to that of the American junior agricultural colleges, but the practical and laboratory work is not as complete. Elementary instruction in surveying, theoretical mechanics, and farm machinery is conducted at this time, but because of lack of facilities and equipment little more than theory is taught in these courses. There is a real need for a decrease in the time allocated to theoretical training and a corresponding increase in the amount of laboratory work. If such a transition is to accomplish its purpose, then additional small equipment must be made available and the instructors must be given additional training in order that they may effectively use the additional equipment. In addition to modifying the courses already being taught, there is also a need for the addition of instruction in the subject matter covered in farm shop practices courses in the United States. The average graduate of the Indonesian agricultural high school does not have enough training in the use of his hands and simple tools that one must have if machinery or mechanical power is to be effectively used. A part of the custom

of expecting uneducated laborers to perform any task that involves manual labor may well originate in the lack of personal conficence in one's ability to perform a task satisfactorily.

The urgent need for improvement in the elementary phases of agricultural engineering covered in the high schools is more apparent if one remembers that here this high school usually is preparatory for college.

3. Complete Training at the University Level.

At the present time there are two agricultural faculties or colleges in Indonesia; both are inadequately staffed and equipped and to introduce complete agricultural engineering training at either will be difficult. There is a greater opportunity of an agricultural engineering curriculum being established in the new Gadjah Madah University at Jogjakarta than in the Agricultural Faculty at Bogor. Gadjah Madah is a new university established since the war and consists of the several faculties or colleges making up a complete university, whereas the institution at Bogor is an agricultural college with its faculties or schools of general agriculture, forestry, and veterinary medicine. It will be easier for a curriculum to be established at Gadjah Madah where there is the related college of engineering in which the fundamental engineering courses may be obtained than at the faculty at Bogor where

the complete curriculum would have to be taught in the agricultural college alone. A secondary factor of importance is that since Gadjah Madah University was established after the war it is less bound by tradition and is more likely to adopt any curricula that seem necessary to meet the needs of Indonesian agriculture.

If agricultural engineering is to make its full contribution to the development of Indonesian agriculture, there must be facilities provided for training Indonesian personnel within Indonesia with the emphasis upon Indonesian conditions and the particular applications of the science that are of importance. To permit a minimum degree of specialization within the profession, there is a minimum need for forty to fifty agricultural engineers in the Government services alone, and there is no reasonable basis of predicting the number who could be effectively utilized in the various agencies of the Government and in private enterprise. Certainly in a country where the basic economy is so largely dependent upon agriculture and where so many of the agricultural commodities are at least partially processed prior to export, the demand for agricultural engineers will far exceed the number available for many years to come.

4. Immediate Research Requirements

In Indonesia where there are the potential benefits

from the applications of agricultural engineering that are visible and where the need for rapid advancement in all phases of agricultural technology is so great, there is an urgentneed for research in all agricultural sciences. There is an even greater need for the collection and analysis of information now available through Government and private resources and the immediate dissemination of the worthwhile information through existing agencies to the segments of the agricultural industry where the information may be useful. The tendency to retain information until machinery is complete, until the best of several cultural practices is absolutely proven, or until the most efficient and perfect processing technique is developed must be discarded; when information indicates that something is better than that which is commonly used, then the information should be distributed as widely and as quickly as possible.

In view of the plans for land development through the use of mechanical equipment, perhaps the most immediate need for research by the Government is accurate information relative to the efficiency of tractors of various sizes and designs used with equipment of various sizes and designs under the varying conditions of topography, soils, and vegetation under which machinery will operate. The collection of accurate information of this nature will be of value to the Government in planning additional purchases of equipment, in planning schedules for future operations, and in the

preparation of operating budgets for equipment and personnel. The information would also be of value to the agricultural estates and to the few individual farmers or small cooperatives who are planning to purchase tractors and machinery in the near future. A little information of this nature is available from the estates now, but in the future operations of the Mechanization Division of the Farmers' Agricultural Service will be the best source of information under a wide range of conditions.

From the standpoint of machinery operation, accurate information on the most economical method of eradicating alang-alang grass is of the greatest importance to the Mechanization Division at this time. Information needed includes the sequence of plowing and harrowing, the depth of plowing and harrowing, number of times plowing and harrowing is necessary, the desirable interval between operations, and the capabilities, limitations, and cost of operation with various types of equipment. The entire operation of the Division, as well as that of the Government Agricultural Estates, especially for the next year or two, should furnish much valuable information on which to base future plans for the use of machinery.

From the standpoint of information of the most universal value to Indonesian farmers, research in methods of decreasing the labor requirements for the production and processing of rice, corn, cassava, and coconut oil will be

of the greatest value. The list of desirable research projects in which agricultural engineering is of major importance either in production or in processing is almost unlimited, and little is to be gained here by a simple listing because there is no organization to carry out such research at this time.

There is a need for the establishment of a department of agricultural engineering in the Central Agricultural Experiment Station, but there are no qualified personnel to carry out the work at this time. When personnel are available, the department should be established and should immediately concern itself with the adaptation to Indonesian conditions of fundamental agricultural engineering knowledge from other parts of the world. While such a department should plan and conduct as much research work as its personnel can undertake, it seems likely that it could make a greater contribution more quickly by collecting and analyzing information that could be obtained from farmers and from estates throughout the Archipelago. When it is established, the department should be able to arrange for much of the actual research work to be carried out cooperatively by other Government agencies and by private enterprises with the Experiment Station bearing the extra expense for record keeping and other variations from normal production techniques.

F. Training Program and Technical Assistance

1. Training Abroad

Because adequate facilities for training personnel, either in specialized phases of agricultural engineering or for general training in all phases of the sciences, are not available in Indonesia, it has been desirable to send limited numbers of the best qualified men abroad for training. The principal engineering activity of the Ministry of Agriculture at this time is in the field of farm power and machinery; therefore, the initial personnel sent abroad were sent for specialized training in this field. The principal difficulty encountered in sending personnel abroad for training is the lack of qualified men in all of the various fields of specialization that are necessary; if agricultural engineering were the only science involved, there would be no particular problem, but when extension specialists, statisticians, agronomists, pedologists, and specialists in all other fields are needed there are not enough men to be sent. It has been necessary for the Ministry of Agriculture to disapprove proposals to send several men abroad for training not because they were not qualified, not because the additional training was not wanted, but because if the men were sent there was no one who could fill their positions while they were absent. While the increased attendance at the agricultural high schools and the agricultural colleges will alleviate this condition in the future, their effect is not yet of consequence.

In 1952 a jointly financed project was arranged between the Ministry of Agriculture and the Mutual Security Agency for fourteen men to be sent to the United States for approximately eight months training in farm power and machinery. These men received a total of approximately 1,100 hours of classroom and laboratory instruction in a special six months' non-credit course. The emphasis of the course was on the operation and maintenance of tractors and machinery of all sizes but was supported by courses in machine shop practice, soils, and simple surveying. The institutional training was followed by an inspection tour to observe machinery applications in land development in Texas and Florida before the men returned to Indonesia to work, with one exception, in the Farmers' Agricultural Service. This man is employed in the land development section of the Transmigration Service of the Ministry of Social Affairs.

In 1953 six men have gone to England for six months' training at the school operated by the Ferguson Tractor Company with their travel expenses being paid by the Hatta Foundation and the expenses within England by the Ferguson Tractor Company and their representative. The Hatta Foundation is named in honor of the Vice President of Indonesia and was established to assist worthy youths to obtain training abroad. Another project proposes to send a maximum of 34 additional trainees to the United States for training in agricultural engineering.

Three men who are responsible for the general supervision of machinery will make an inspection tour of several areas in the United States to observe methods of machinery operation and maintenance in land development, irrigation, and mechanized rice culture. Enroute to or from the United States they will stop for two weeks in India to observe the organization and operation of the Central Tractor Organization of the Indian Government which is carrying out a large-scale land development program.

A maximum of fourteen men will be sent to the United States for a program in the utilization of tractors and machinery. The program desired for these men is almost identical with that given for the previous trainees with a little more time for institutional training and a corresponding decrease in the time spent on inspection trips. These men will work with the Mechanization Division upon their return.

A maximum of seven men will be sent for approximately eight months' training in farm shop practices, simple surveying, tractors and machinery, and methods of teaching these subjects. The emphasis of this training will be on practice and laboratory work to enable the trainees to acquire sufficient skill to teach these subjects in the agricultural high schools upon their return. Because of the shortage of teachers some of these men who are employees of the Farmers' Agricultural Service will be assigned upon their return to cities where the agricultural high schools are located and will teach part time and work in extension activities the remainder of the time.

A maximum of ten men will be sent for general training in agricultural engineering and in the course of their training should qualify for the Bachelor of Science degree. It is estimated that the training time required for these men will be between two and three years with three men who are graduates of Gadjah Madah University probably completing the work for the Master of Science degree also. At least one of the trainees will be an instructor at Gadjah Madah University upon his return, and the others will be in various positions of the Ministry of Agriculture where their training will be of maximum benefit.

While the above training abroad is admittedly inadequate for the needs of Indonesia at this time, it is the maximum possible because additional personnel to be sent for training either are not available or cannot be spared from their work because of the lack of capable substitutes until some of these trainees return. While inadequate in numbers and in scope of training, to send approximately fifty trainees abroad in two years indicates a growing realization of the importance of agricultural engineering on the part of officials who prior to 1951 had virtually no concept of what the science encompassed or what its potential contributions to Indonesian agriculture might be.

2. Training Within Indonesia

The first attempt to give training in specialized phases of agricultural engineering in Indonesia was a short course on the installation and operation of pumps for supplemental irrigation arranged through the cooperation of the local representative of the pump manufacturer who supplied the 10 and 15 horsepower pumps previously referred to, the Farmers' Agricultural Service, and the United States Special Technical and Economic Mission. This short course was given for ten employees of the Farmers' Agricultural Service, who at the time the course was conducted were to be responsible to the installation and operation of the pumps. The employees of the Service were assembled at the expense of the Service which also paid the incidental costs of the course. It is impossible to evaluate the effectiveness of the course because the responsibility for the installation and operation of the pumps was transferred to the Irrigation Division of the Ministry of Public Works and Power shortly after the course was completed.

In July 1952, a school to conduct training in the operation and maintenance of tractors and machinery was opened by the Mechanization Division of the Farmers' Agricultural Service at Pasar Minggu near Djakarta. The

objective of this school initially is to train employees of the Mechanization Division for positions of senior operators and junior supervisors. In order to accomplish its objective the school will conduct courses of approximately three months' duration, in which the theoretical instruction will be kept at an absolute minimum and most of the instruction will be accomplished through the "learn by doing" technique so that those who complete the courses, when assigned to the land development equipment pools, will be able to instruct tractor drivers and machinery operators in the correct procedures of operation and of preventive maintenance.

The organization of the school, the content and duration of the courses, and the methods of instruction were determined originally by discussions between the chief of the Mechanization Division and the author after a recommendation by the latter for the establishment of the school forwarded to the Ministry of Agriculture in February 1952, and have been modified since the arrival of another agricultural engineer from the United States who is working full-time with the school. In the original plans for the school the training of maintenance personnel was also included but has not yet been possible because of lack of personnel and equipment for maintenance instruction. Upon the return of the first fourteen trainees from the United States in March 1953, one was assigned as the director and full-time instructor at the school and a second assigned to assist as a part-time instructor. These assignments increased the efficiency of the school, for prior to their return there were no qualified Indonesian instructors, and the language barrier made it impossible for the American agricultural engineer to do an effective job. At the present time with these reasonably well qualified men to conduct the instruction assisted by the guidance and general supervision of the American, much better instruction is being accomplished. As the operation of the school continues and the urgent needs for personnel in the Mechanization Division diminishes, it is planned that personnel from the General Extension Division of the Farmers' Agricultural Service will be admitted to the course so that they will be qualified to advise farmers on power and machinery applications. When possible, personnel from other Government agencies and from private enterprise will also be admitted.

It is planned that each of the land development equipment pools will conduct practical instruction in the actual operation and maintenance of machinery. Trainees returning from the United States are being assigned to senior supervisory positions, and assisted by the men trained at Pasar Minggu, they will conduct such training as is necessary to insure the safe, effective, and economical operation and maintenance of equipment.

As referred to in the previous section, current plans propose to send men to the United States for training to qualify them to become instructors in the agricultural high schools for elementary phases of agricultural engineering. When these men return, the scope of instruction presently given will be slightly enlarged and the emphasis shifted from theoretical to practical aspects of such training. The subject matter covered will be arranged so that graduates of the high schools will have less theoretical knowledge but will be able to use the training they have received. The theoretical subject matter should properly be covered at the university level. For the high school graduates who do not attend college the comprehension of theory is unimportant, while the application of principles is of primary concern.

In order for the applications of agricultural engineering to make the greatest contribution to the development of Indonesian agriculture, provisions must be made as soon as possible to give complete agricultural engineering training in Indonesia. There is a greater possibility of such instruction being given in Gadjah Madah University than in the Agricultural Faculty at Bogor because of the limited scope of training presently being given in the latter institution. If Indonesian agriculture is to receive the maximum benefit from educational and research institutions, there must be more schools and research institutions

established. It seems that the real needs of Indonesia will not be satisfied in agricultural engineering or any of the other agricultural sciences until there is at least the equivalent of at least one land-grant college in each province and a branch of the Central Experiment Station functioning as an integral part of each college so that the subject matter taught in the colleges can be closely correlated with the latest information available on Indonesian agriculture. The need for vocational agricultural high schools is impossible to estimate; there are now six, but 1,400 would be required to meet the minimum desirable requirement of having one in each sub-district of the present administrative organization of the Government.

It is safe to predict that the rate of establishment of the educational institutions needed will progress at an accelerated rate in the future. For anyone to attempt to predict the rate beyond stating that personnel limitations will cause progress to be slow is impractical.

3. Foreign Technicians

Until training institutions can be established in Indonesia in sufficient numbers to provide the agricultural engineers and other scientists necessary for the implementation of essential programs, it will be desirable for foreign technicians to assist in most fields. Most technicians should be employed for short periods either by the

Indonesian Government, through international assistance agencies, or through the assistance programs of foreign powers such as the Point IV Program of the United States and the Colombo Plan of the British Commonwealth of Nations. The primary objective of each technician brought to Indonesia should be to work himself out of a job as quickly as possible by training an Indonesian to replace him when he returns to his own country. Admittedly this objective will be easier to accomplish in the administrative fields than in the technical fields, but the only difference should be in the minimum time required for the accomplishment of the objective. The Indonesians have had the benefit of the technical direction by employees of the former Netherlands Indies Government, personnel who were often more interested in their personal advancement and the completion of the twenty years required for retirement than they were in training Indonesian personnel; such an attitude of self-perpetuation is not acceptable under the present conditions in Indonesia.

The Indonesian Government is obtaining technical assistants in the various agricultural sciences as well as in other fields of endeavor through direct contracts with individuals, through international agencies such as the Food and Agricultural Organization of the United Nations, and through the Colombo Plan; but to date agricultural engineering assistance has been through the Technical Cooperation Administration of the United States. The need for technical assistants will continue and will probably even increase for the next five to ten years, after which time it should decline as Indonesian personnel can be trained abroad and can return to establish training facilities to meet the minimum personnel requirements of the Government agencies and private industry within the country. There will probably remain a need for years to come for outstanding authorities to come to Indonesia for short periods of study and consultation on particular problems, but even this need should almost disappear after about twenty years.

G. Conclusion

The diversity of Indonesian agriculture, together with the varied degrees of development and the marked changes in climatic and soil conditions, offer vast opportunities for the profitable applications of agricultural engineering. The educational level of the people and the lack of adequate educational facilities will retard the efficient applications of engineering principles, and the lack of industrialization to provide profitable employment of labor that may be replaced with mechanical power or machinery will further decrease the rate of advancement possible. In spite of these difficulties if the present aggressive leadership present in the Ministry of Agriculture at this time continues, a marked advancement will occur within the next few years and will serve to raise the general level of agricultural production and particularly the productivity of agricultural labor. Advancement in agricultural engineering, accompanied by advancement in the other agricultural sciences, will improve the standard of living of the people and the economy of the country.

SELECTED BIBLIOGRAPHY

1. Berlage, H. P., Jr., Regenval in Indonesia (Rainfall in Indonesia), Verhandelingen Number 37, Departemen Van Verkeer en Geophysische Dienst Koninklijk en Meteorologisch Observatorium, 1949, 212 pp.

2. Boeke, J. H., The Evolution of the Netherlands Indies Economy, Institute of Pacific Relations, New York, 1946, 172 pp.

3. Bone, S., Transmigration of Demobilized Personnel, Djawatan Pertanian Rakjat, Propinsi Sulawesi, Oct. 23, 1950, Unpublished report, 4 numbered leaves.

4. Covarrubias, Miguel, Island of Bali, Alfred A. Knopf, New York, 1950, 417 pp.

5. Dames, T. W. G., Personal Communication, May 20, 1953.

6. _______________, Some Notes on the Soil Survey of Java, Reprint from Commonwealth Bureau of Soil Science, Technical Communication Number 46, 1949, 6 pp.

7. De Haan, J. H., Adequate Water and Land Use, O.S.R. News, Djakarta, Oct. 1950, pp. 2-10.

8. _______________, The Economic and Social Aspect of Erosion Control, Paper presented ECAFE Flood Control Congress, New Delhi, India, Jan. 1951, lithographed, 8 pp.

9. _______________, Scientific Investigations Concerning Adequate Water and Land Use, O.S.R. News, Djakarta, Oct. 1950, p. 131.

10. Djawatan Penerangan Propinsi Kalimantan, Pembukaan Kalimantan, Bandjarmasin, Dec. 1951, 28 pp.

11. Embassy of Indonesia, Information Division, Republic of Indonesia, The Country, The People, The History, Washington, 1951, 80 pp.

12. Goldberg, Harry, Foreign Observers on the Question of West Irian, Ministry of Information, Republic of Indonesia, Djakarta, 1952, 7 pp.

13. Hannibal, L. W., Peta Kalimantan (Map of Kalimantan) 1/2,500,000, Planning Division, Forestry Service, Ministry of Agriculture, Bogor, Indonesia, 1950, 1 sheet.

14. Kantor Pusat Statistik, Ichtisar Bulanan (Monthly Survey), Djakarta, July 1952, 81 pp.

15. Kennedy, Raymond, Islands and Peoples of the Indies, Smithsonian Institute, War Background Studies Number 14, Publication 3734, 1943, 62 pp.

16. Kementerian Pekerdjaan Umum dan Tenaga, Informal Report of Bagian Irrigasi, April 1953, 1 map and 6 tables.

17. Koninklijke Paketvaart Maatschappij N.V., Dienstregeling der N.V. Koninklijke Paketvaart Maatschappij voor het Jaar 1953, Djakarta, Indonesia, Nov. 1952, 135 pp.

18. Manoe, Tandiono, Peraturan Menteri Pertanian, Kementerian Pertanian, Djakarta, 1951, Mimeographed, 17 pp.

19. Melhus, Irving W. and Jackson, Robert I., Corn Production in Indonesia, General Agricultural Experiment Station, Bogor, Indonesia, 1952, Mimeographed, 84 pp.

20. Metcalf, John E., The Agricultural Economy of Indonesia, Agricultural Monograph Number 15, United States Department of Agriculture, Washington, 1952, 100 pp.

21. Ministries of Economic Affairs and Agriculture, Ekspor Dari Indonesia Dalam Tahun 1951-1952, Warta Ekonomi, Tahun Ke-5, No. 11, 1952, Djakarta, Indonesia, p. 193.

22. Ministry of Information, Difficulties of Cabinet Formation, Indonesian Affairs, Djakarta, Indonesia, Feb.-Mar. 1952, pp. 1-7.

23. __________________, Indonesia, Country, People, Transition and Future, Djakarta, Indonesia, 1951, 198 pp.

24. __________________, Indonesia Today, Agriculture and Fisheries, Djakarta, Indonesia, 1951, leaflet, 4 pp.

25. __________________, Indonesia Toady, Communications, Djakarta, Indonesia, 1951, leaflet, 4 pp.

26. ____________________, Indonesia Today, Education and Science, Djakarta, Indonesia, 1951, leaflet, 4 pp.

27. ____________________, Indonesia Today, Exports, Djakarta, Indonesia, 1951 leaflet, 4 pp.

28. Ochse, J. J. and Van Den Brink, R. C. Bakhuizen, Fruits and Fruit Culture in the Dutch East Indies, G. Kolff and Company, Batavia (Djakarta), Indonesia, 1931, 188 pp. and 57 plates.

29. Payne, Robert, The Revolt in Asia, John Day, New York, 1947, 299 pp.

30. P. I. Aneta News Bulletin, Two Years of Civil Aviation in Indonesia, Djakarta, Indonesia, Mar. 18, 1952.

31. Pino, E., Bahasa Indonesia, J. B. Wolters, Djakarta, Indonesia, 1950, 152 pp.

32. Polak, B., Construction and Origin of the Floating Soils of the Rawah Pening (Central Java), Contribution General Agricultural Research Station Number 121, Bogor, Indonesia, 1951, 11 pp.

33. Roth, Andrew, Indonesian Government Crisis, Far Eastern World Affairs, 45 Dorset Street, London, May 1952, pp. 11-12.

34. Saksono, Prawirohardjo, Sekedar Mengenai Organisasi dan Usaha Pusat Perkebunan Negara, Almanak Pertanian 1953, (R. Soetijo, Editor), Kementerian Pertanian, Djakarta, Indonesia, 1952, pp. 303-316.

35. Schopuys, H. J., Rubber Production in South Kalimantan, Personal Communication, Nov. 1951, 1 table.

36. ______________, Regional Development Corporation Polderplan Kalimantan, Djakarta, Indonesia, Feb. 8, 1953, Mimeographed, 7 pp.

37. Soetijo, R., Editor, Almanak Pertanian 1953, Kementerian Pertanian, Djakarta, Indonesia, Nov. 1952, 382 pp.

38. Ter Braake, Alex L., Mining in the Netherlands East Indies, Bulletin Number 4, Netherland and Netherlands Indies Council, Institute of Pacific Relations, New York, 1944, 110 pp.

39. Times of Indonesia, West Java Security Conditions in 1952, Djakarta, Indonesia, Oct. 1, 1952.

40. Ukers, William H., All About Tea, Volume I, The Tea and Coffee Grade Journal Company, New York, 1935, 559 pp.

41. Van De Goor, G. A. W., Rice Cultivation in Indonesia, General Agricultural Experiment Station, Bogor, Indonesia, Mimeographed, 6 pp.

42. Van Der Vorte, M. and Van Es, F. W. J., Soil Survey of the Mbai Plain, Contribution General Agricultural Research Station Number 124, Bogor, Indonesia, 1951, 29 pp.

43. Van Doormaal, J. C., Agricultural Conditions of Flores, Personal Communication, Nov. 22, 1952, 5 numbered leaves.

44. Van Wijk, Chr. L., Problems in Mechanical Tillage of Lalang Plains, Reprint from Tectona, Dl. XLI, 1952, pp. 29-35.

45. ________________, Soil Survey of the Tidal Swamps of Borneo in Connection with the Agricultural Possibilities, Contribution General Agricultural Research Station Number 123, Bogor, Indonesia, 1951, 49 pp.

46. Vlekke, Bernard H. P., Nusantara, Harvard University Press, Cambridge, Mass., 1945, 421. pp.

47. Wolf, Charles, The Indonesian Story, John Day and Company, New York, 1948, 191 pp.

48. United States War Department, Medical and Sanitary Data on Java, TB. MED 102, Washington, 1944, 45 pp.

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