# Khmer-Japanese Friendship Agricultural Technical Center

## 1970 Annual Report

27212

Submitted October 1970

Overseas Technical Cooperation Agency

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Part 2

# Introduction

We arrived at Phnom Penh Airport on September 21, 1969 prepared to relieve the Japanese technical staff there and begin a two year assignment at the Khmer-Japanese Friendship Agricultural Technical Center. Unfortunately, after only a little over half a year, fighting broke out in Cambodia. The Japanese technical staff was evacuated in June, first to Phnom Penh and then, at the end of the month, to Bangkok, Thailand where we were instructed to stand by. As hostilities worsened, however, we were obliged to return to Japan.

In spite of our ignorance of the Khmer language, we had managed to get a grasp of work at the Center and were looking forward to beginning in earnest as the rainy season began. However, just as we were poised to do so, events in Indochina took a regrettable turn for the worse.

When we set out on our overseas assignment, we received the following instructions from OTCA (Overseas Technical Cooperation Agency): "The Agricultural Center has now been in operation for five years and we strongly feel that the time has come for the Center to be managed and operated by Khmer personnel. During your two year assignment, we'd like you to give serious thought to preparing the ground for this transition and share your ideas on the subject with us." In accordance with this directive, we resolved to put a strong emphasis on training the Khmers to independently conduct their own testing and research. It was decided that the Japanese technical staff would no longer play the leading role in the conduct of testing and research. Instead, we would encourage the Khmer personnel at the Center to assume responsibilities and provide them with guidance where needed.

In accordance with the new management policy, Khmer personnel were asked to take responsibility for tabulating test results for the 1969 wet season crop. Surprisingly, their calculating abilities proved extremely poor and little progress was made. Nevertheless, in order for the Khmer personnel to acquire the skills required during the two year period allotted to us, it was essential that they get familiar with the work as soon as possible. For our part, we did our best to guide them. When word came that we were to be immediately evacuated from Cambodia, we tried to carry out as much test data as we could. Unfortunately, however, some unfiled materials did get left behind. We subsequently requested that data be sent, but got no reply. Needless to say, results for the 1969 wet season crop were incomplete.

As for the 1970 dry season crop, Khmer personnel, citing the danger of rat damage, were extremely lax in carrying out tests. By emphasizing the government's expectations with respect to the dry season crop, however, we were able to persuade them to independently conduct a small number of tests relating to rat prevention techniques. Although an electrical fence was devised to keep out rats -- with respect to rat prevention, thanks to the research staff of the Tropical Agriculture Research Center for their tremendous assistance -- as law and order continued to deteriorate and the area around the Center became so dangerous at night that an armed guard was required to patrol the premises, rat damage had become extremely heavy by the beginning of May and testing had to be discontinued. Under the circumstances, it proved impossible to obtain results for the dry season crop.

The plans for testing on the 1970 wet season crop were designed with a strong emphasis on Khmer personnel working independently. Since the plan was kept within the scope of the abilities of Khmer personnel working on their own, results were highly rudimentary. This was deemed acceptable in light of the fact that autonomy was being transferred to them.

With respect to the current dispatch of personnel, a great deal of importance was placed on dispatching a plant breeding specialist to the Center. It is regrettable that personnel selection difficulties prevented this from happening.

This report is designed to explore the direction that subsequent testing and research for improving the Cambodian rice crop should take and the problem points related to this objective. At the risk of being redundant, this report begins with a summary of the natural environment in which rice is cultivated in Cambodia and a description of rice cultivation as it is practiced there under the given environmental conditions. We then go on to discuss the kind of work being done at the Center and the problem points that have emerged in the process. Finally, we attempt to identify problems which will need to be solved in future. We would like once again to point out that we had only a very short time to land experience, make contacts and gather data. We therefore ask that the reader excuse us for those places in this report where we may have overlooked, or dealt too superficially with, an important issue.

In closing, we would like to take this opportunity to express our heartfelt thanks for the guidance and help we received during our stay in Cambodia from the experienced staff of OTCA and the Japanese Ministry of Agriculture and Forestry.

October 1970

Technical Staff dispatched to the Cambodia Agricultural Technical Center
Saika Chuzo, Group Leader
Hiratsuka Toshio, Soil and Fertilizer Specialist
Horibata Toshizo, Cultivation Specialist
Sugawara Seikichi, Agricultural Machinery Specialist

## Part 1

## I. Rice cultivation in Cambodia

### 1. Climate

Cambodia is located in the southwest central section of the Indochina Peninsula lying between longitude 10x-15x and latitude 102x-108x. The country forms an irregular reverse trapezoid. The eastern highlands of Cambodia border on Vietnam; the Cardamom Mountains in the west border on Thailand; and the Dan Raek Mountains in the north border on Laos and Thailand. The south of the country faces the Vietnamese Plain and the Gulf of Siam. Roughly speaking, the south of the country forms an open-mouthed basin.

In west central Cambodia lies Lake Tonle Sap, the surface area of which, we are told, varies from 3,000 square kilometers in the dry season to 10,000 square kilometers in the wet season. Flowing from north to south in east central Cambodia is the Mekong River which is connected to the lake by the Tonle Sap River.

Tropical Cambodia owes its rainy climate to the Asian Monsoon. There are two seasons: a rainy and a dry season. During the rainy season, from May through October, a maritime southwesterly bearing large amounts of moisture predominates and brings rain to the subcontinent. The dry season from November through April occurs when a dry northeasterly from the mountains predominates.

As Tables #1 and #2 show, though rainfall may vary considerably from year to year and place to place, most regions of the country receive a yearly rainfall of about 1,500mm, 80 - 90% of which falls between May and October. Obviously then, rainfall is very sparse during the dry season. In the rainiest of dry seasons, rainfall between October and March does not exceed 100mm. The average yearly temperature is 27xC. Temperatures are lowest in December and January when the average is about 25xC, and highest in April at the end of the dry season when the average is around 29xC. On the basis of average monthly temperature statistics, the variation between the coolest and hottest months is only 4xC. By way of comparison, daily temperature ranges display a variation of 5 - 10xC, with ranges smaller during the rainy season and larger in December and January during the dry season. The shortest day of the year, in December, is 11.4 hours long, and the longest, in June, is 12.8 hours long. This means that the seasonal difference in day length in Cambodia is only 1.4 hours. Oddly enough, in terms of average daily hours of sunlight, even with its shorter days the dry season is sunnier than the rainy season. In 1969, for instance, the average duration of sunlight during the short days of the dry season was 7.7 hours, while that for the long days of the wet season was 5.5 hours. (See Table #1.) Based on these statistics, the dry season is best suited for rice cultivation, provided of course water resources are under control.

Although the period between May and October is the official rainy season, the season actually varies from year to year. Some time during June - July there is a two or three week period of reduced rainfall known as the 'little dry season'. When it actually occurs, however, will vary also depending on the year.

Owing to the low elevation of Cambodia's central plain, when the Mekong swells with water from its upper reaches, the Tonle Sap River reverses its course and a portion of the waters of the Mekong flow into Lake Tonle Sap, thereby raising its water level. This back flow, in combination with domestic rainfall, gradually raises the lake's water level until the surrounding central plain is inundated. This tranquil flood peaks around the end of September when the waters begin to recede. Harvesting begins around November when the waters have completely receded and the fields have dried.

In those years in which the flood waters rise higher than normal, vast sections of the paddy fields may be submerged with some accompanying damage to the crop. Nevertheless, the worst damage to the rice crop is caused by a lack of water. Insufficient rainfall during the rainy season may be the cause of widespread severe crop damage. It was reported, for instance, that the harvest failed in 20% of the area cultivated during the 1968 rainy season for lack of water.

In this country blessed with warm temperatures and abundant sunshine, water is the crucial component for insuring a good harvest. If Khmer farmers can succeed in getting control of water, substantially increased production will be possible.

Table #1: Climate table (Battambang City)

| Month | Climate in normal years | | | | 1969 | |
|---|---|---|---|---|---|---|
| | Average monthly temp. (average for 29 years) | | | Average monthly rainfall | Rainfall | Duration of sunlight (Daily average) |
| | Maximum temp. | Minimum temp. | Average temp. | (Ave. for 44 years) | | |
| | °C | °C | °C | mm | mm | hours |
| 1 | 31.2 | 19.0 | 24.7 | 5.1 | 2.1 | 8.2 |
| 2 | 33.3 | 21.1 | 26.7 | 16.2 | 2.4 | 8.7 |
| 3 | 35.3 | 23.0 | 28.6 | 51.2 | 50.3 | 7.2 |
| 4 | 35.9 | 24.1 | 29.4 | 85.5 | 61.3 | 7.0 |
| 5 | 34.3 | 24.6 | 28.4 | 153.1 | 107.4 | 7.0 |
| 6 | 33.3 | 24.6 | 28.2 | 144.7 | 149.9 | 5.5 |
| 7 | 32.2 | 24.3 | 27.4 | 167.6 | 203.2 | 3.7 |
| 8 | 32.0 | 24.2 | 27.3 | 171.8 | 187.9 | 6.1 |
| 9 | 31.3 | 24.1 | 26.9 | 247.3 | 257.5 | 4.9 |
| 10 | 30.4 | 23.7 | 26.7 | 238.7 | 235.4 | 5.8 |
| 11 | 30.1 | 22.1 | 25.8 | 82.6 | 118.0 | 6.9 |
| 12 | 30.1 | 19.7 | 24.5 | 18.1 | 0.1 | 8.4 |
| Average | 32.4 | 22.9 | 27.0 | 1,381.9 | 1,357.5 | 6.7 |

Table #2: Monthly rainfall 1964-1968 for various regions of Cambodia

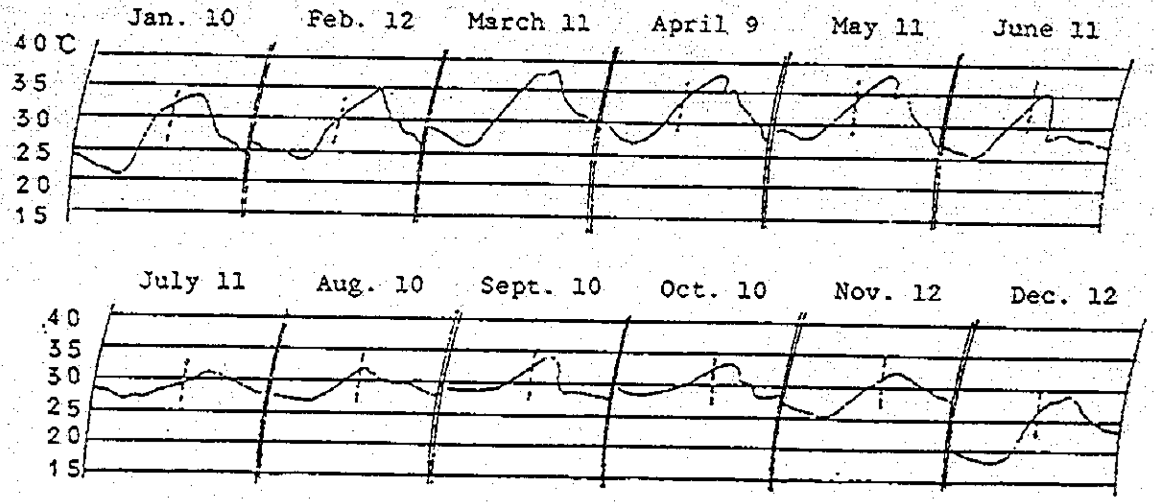
Unit: mm

| Year<br>Region | 1964 | 1965 | 1966 | 1967 | 1968 | Five year average | |
|---|---|---|---|---|---|---|---|
| | | | | | | Monthly rainfall | Yearly rainfall |
| Phnom Penh | 133.3 | 119.7 | 173.4 | 122.9 | 89.6 | 127.8 | 1,534 |
| Battambang | 115.3 | 109.9 | 182.8 | 111.3 | 98.5 | 123.6 | 1,483 |
| Kampot | 132.2 | 182.8 | 163.7 | 202.8 | 179.0 | 172.1 | 2,065 |
| Kompong Cham | 137.0 | 140.3 | 150.7 | 151.8 | 128.7 | 141.7 | 1,700 |
| Sihanoukville | 265.9 | 348.0 | 405.0 | 409.6 | 252.8 | 336.3 | 4,036 |
| Siemreap | 121.4 | 112.6 | 139.9 | 155.8 | 88.8 | 123.7 | 1,484 |
| Stung Treng | 143.9 | 154.3 | 168.3 | 187.3 | 148.5 | 160.5 | 1,926 |
| Svay Rieng | 160.0 | 166.3 | 201.4 | 145.0 | 169.6 | 168.4 | 2,021 |
| Pursat | 144.3 | 120.7 | 191.4 | 154.4 | 115.6 | 145.3 | 1.744 |

Note: Average yearly rainfall for Phnom Penh based on 66 years of statistics is 1,383.7mm and that for Battambang based on 44 years of statistics is 1,381.9mm.

Figure #1: Daily temperature ranges (1969)

Temperatures recorded at the Khmer-Japanese Friendship Agricultural Technical Center in Battambang



Note: 1. An effort was made to select more or less typical days around the tenth of each month.
2. Please note that, in terms of absolute values for temperature, the above chart may not necessarily be representative for each month.

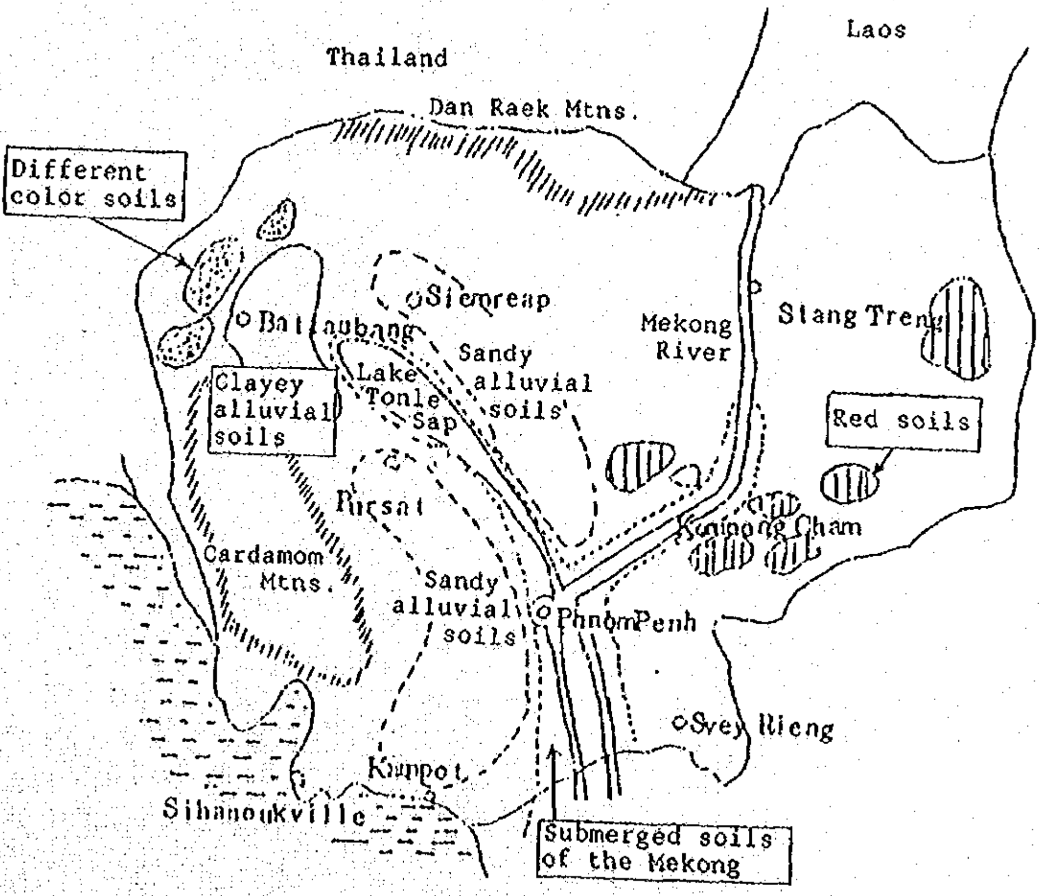
## 2. Soil

In terms of research on the soils of Cambodia, there is the detailed study conducted by Saeki et.al. in 1959 and a study conducted by an American team in 1962. This latter study identified 16 soil types in Cambodia based on constituent analysis with soil cross section measurements on samples from 118 different sites in the country.

Based on Yasuo's work, which focuses primarily on cultivated soils, the following classification was derived. Geographical distribution is noted in the figure below.

1)

- Lowland alluvial soils
  - Submerged soils of the Mekong
  - Sandy alluvial soils
  - Clayey alluvial soils
- Tableland sedimentary soils
  - Red soils
  - Black Soils



Distribution of Cambodia's principle farming areas

Submerged soils of the Mekong

These are alluvial soils which are resupplied with fresh silt each year when they are submerged by flood waters from the Mekong and Lake Tonle Sap during the rainy season. During the period before and after inundation, these lands are employed for field crops such as corn, tobacco, green beans, peanuts and sugar cane, while some are used to cultivate floating rice and the dry season rice crop.

Sandy alluvial soils

The soils supporting 2/3 of Cambodia's wet rice fields are sandy alluvial soils. During the rainy season, these lands are mostly planted in wet rice and during the dry season some of this land is employed for the cultivation of fruits and vegetables.

Clayey alluvial soils

This clayey soil is lake alluvium from Tonle Sap and it supports 1/3 of Cambodia's paddy fields. It is employed primarily for one wet rice crop during the rainy season. In the dry season it turns into savanna.

Red soils

This red-colored tableland soil is composed of weathered quaternary basalt and lava. With its relatively good physical properties, red soil land is employed for a wide variety of different crops including rubber, coffee, pepper, pineapples and bananas in addition to corn, cotton and legumes.

Black soils

This soil is composed of weathered limestone from Paleozoic strata. It owes its peculiar black color to high levels of humus. Thanks to its relatively good physical properties, black soil land, in addition to cotton, is also suitable for bananas and legumes.

As you can see, from sandy soils to humus, Cambodia is endowed with a wide variety of soil types differentiated by color, structure and other properties. Paddy fields take up 85% of the country's arable land. The two largest rice growing areas are the Lake Tonle Sap area with its sandy alluvial soils followed by the region centered around Battambang Province. This region features clayey alluvial soils and is known as the country's 'grain basket'.

With respect to the chemical composition of soils, as past analyses have clearly shown, Cambodian soils are characterized by their low phosphate content. Furthermore, looking at fertilizer test results, the application of phosphatic fertilizer has been shown to be an important factor in boosting paddy yields. Although Cambodian soils are somewhat on the acidic side, this is not viewed as problematic for the wet rice crop. Though the soil is not particularly rich in potassium, application of potassic fertilizers has not produced any noteworthy results. Currently, potassium is not even being raised as an issue when discussing fertilizers. In some areas, there are accumulations of sulphates which have caus yearly salt damage to crops.

## 3. The present state of rice cultivation and associated problem points

### 1) The position of rice cultivation and its infrastructure

The relative weight of Cambodia's secondary industries is extremely small. Agriculture is the country's main industry, generating approximately 40% of the gross national product. (See Table #3.) The most important crop is rice, which constitutes more than half of agricultural production. Rice is also the country's largest export product. Out of a total of 2.9 billion riels in export earnings (1967), rice exports made up 44% of the total. Earnings from rice exports were 1.7 times larger than those for rubber, the second most important export product. (See Table #4.)

Cambodia has a land area of 180,000 square kilometers (18 million hectares). About 50% of this land area, or 8.8 million hectares, are level plain, 6.7 million hectares of which are potentially arable. However, due to unfavorable land conditions (mainly problems relating to water) and regions with sparse population, arable land development has not progressed. As a result, only 3 million hectares of the country are presently under cultivation. (See Table #5.) Wet rice cultivation accounts for 2.3 - 2.5 million hectares. That means that over 80% of the land under cultivation is devoted to paddy fields. Since the rice crop is dependent on rainfall, the yearly variation in the size of the land area planted in wet rice is a reflection of rainfall conditions in that year.

In spite of the tropical climate, which should facilitate double cropping, due to the poor state of repair of irrigation facilities, most areas are restricted to a single rice crop during the rainy season. The dry season crop is limited to those areas which could not be planted during the rainy season because the water was too deep and to the extremely small area of the country that can be irrigated during the dry season. This amounts to only 4-5% of the area planted yearly. (See Table #9.)

Cambodia has 840,000 farming households which constitute 77% of the total number of households in the country. (See Table #6.) It is said that each farming household has an average of 3 hectares of arable land. It should be noted, however, that regional differences in average farm size are rather large. Battambang Province is well above the national average with an average farm size of 5 hectares, while farm size in other provinces tends to be relatively smaller. Thirty percent of farm households are reported to have holdings of less than 1 hectare, while only 14% of farm households have holdings of more than 5 hectares. (See Table #7.)

Average yield, at around one ton per hectare, is extremely low. It would not be technically difficult to double or triple yields by applying fertilizers, but the extreme poverty of the farm population and insecurity about the effects of fertilizer on the harvest are potent barriers to the widespread introduction of fertilizer-enhanced cultivation.

Table #3: Gross National Product of Cambodia (1966)

| | Monetary value | % of total |
|---|---|---|
| Primary industries/Share of agriculture | In millions of riels<br>13,119.6 | %<br>47.5 |
| | 11,215.9 | 40.7 |
| Secondary industries | 5,411.8 | 19.6 |
| Tertiary industries | 9,111.3 | 33.0 |
| Totals | 27,642.7 | 100.0 |

Table #4: Export products and their respective shares of total exports

Monetary unit: millions of riels

| | 1966 | | 1967 | |
|---|---|---|---|---|
| | Monetary value | % of total | Monetary value | % of total |
| Total | 2,356 | 100.0 | 2,906 | 100.0 |
| Total of agricultural, marine and forest products | 2,305 | 97.8 | 2,576 | 88.6 |
| Rice | 846 | 35.9 | 1,284 | 44.2 |
| Rubber | 873 | 37.1 | 716 | 24.6 |
| Corn | 285 | 12.2 | 147 | 5.1 |
| Pepper | 59 | 2.5 | 53 | 1.8 |
| Kapok | 99 | 4.2 | 45 | 1.5 |
| | 32 | 1.4 | 63 | 2.2 |
| Green beans | 2 | 0.1 | 43 | 1.5 |
| Peanuts | - | - | 14 | 0.5 |
| Soy beans | 3 | 0.1 | - | - |
| Tobacco | 2 | 0.1 | 17 | 0.6 |
| Animal husbandry products | 39 | 1.7 | 90 | 3.1 |
| Marine products | 6 | 0.3 | 23 | 0.8 |
| Forest products | 59 | 2.5 | 80 | 2.8 |

Source: Statistical Yearbook of Cambodia, 1968.

Table #5: Land utilization (1965)

| Total land area | | 1000s of ha 18,111 |
|---|---|---|
| Forest | | 13,227 |
| Land under cultivation | | 3,016 |
| Break-down | Land usable for rice cultivation | 2,535 |
| | Other annual crops | 242 |
| | Perennial crops | 59 |
| | Rubber plantations | 57 |
| | Swidden agriculture | 123 |
| Uncultivated lands | | 1,868 |

Source: a study by the Forestry Agency

Table #6: Number of farming households - Number of rice farming households (1962)

| Total number of households | Households 1,092,600 |
|---|---|
| Farming households | 842,000 |
| Rice farming households | 666,516 |
| B/A | 77% |
| C/B | 79% |

Source: Agricultural Affairs Agency Statistics - Bulletin No. 6

Table #7: Farm size: Number of households and area farmed

| | No. of farming households | | Land area under cultivation | |
|---|---|---|---|---|
| | Actual No. | % of total | Actual No. | % of total |
| Under 1 Ha | 256,260 | 30.7 % | 126,800 Ha | 5.2 % |
| 1 - 2 Ha | 186,410 | 22.3 | 260,280 | 10.7 |
| 2 - 5 | 272,500 | 32.6 | 926,600 | 37.9 |
| 5 - 10 | 86,930 | 10.4 | 608,510 | 24.8 |
| 10 - 20 | 28,420 | 3.4 | 386,510 | 15.8 |
| Over 20 Ha | 5,020 | 0.6 | 138,050 | 5.6 |
| Total | 835,900 | 100.0 | 2,446,650 | 100.0 |

Source: Statistics Dept. of the Agricultural Affairs Agency - Bulletin No. 3

Cultivated land area devoted to each crop and respective yields (1966-67)

| | Land area planted | Yield | % of total cultivated land | | Land area planted | Yield | % of total cultivated land |
|---|---|---|---|---|---|---|---|
| Totals | 1000s of Ha<br>2,932.4 | 1000s of tons<br>3,290.5 | 100,00 % | | | | |
| Wet rice | 2,513.6 | 2,457.0 | 85.71 | Perennial crops | 151.7 | 358.7 | 5.17 |
| Rainy season | 2,349.8 | 2,274.1 | 80.13 | Sugar palm | 25.7 | 55.5 | 0.87 |
| Dry season | 163.8 | 182.9 | 5.68 | Rubber | 62.2 | 51.4 | 2.17 |
| Annual crops | 267.1 | 474.8 | 1.90 | Bananas | 20.6 | 133.3 | 0.70 |
| Red corn | 102.1 | 134.1 | 3.48 | Coconut palms | 16.0 | 6.3 | 0.54 |
| Green beans | 47.9 | 25.2 | 1.63 | Kapok | 9.4 | 6.9 | 0.32 |
| Vegetables | 16.9 | 169.0 | 0.58 | Mangoes | 7.1 | 48.4 | 0.24 |
| Peanuts | 22.8 | 20.8 | 0.77 | Oranges | 2.8 | 23.4 | 0.09 |
| Tobacco | 17.4 | 10.1 | 0.59 | Pineapples | 2.2 | 15.3 | 0.07 |
| White corn | 14.9 | 15.4 | 0.50 | Mulberry | 0.9 | 0.01 | 0.03 |
| Sesame | 14.6 | 9.8 | 0.49 | Cashews | 1.2 | 0.4 | 0.04 |
| Jute | 8.2 | 1.5 | 0.27 | Pepper | 0.7 | 1.6 | 0.02 |
| Soy beans | 8.1 | 7.3 | 0.26 | Shaddock | 0.5 | 6.4 | 0.01 |
| Sugar cane | 5.0 | 37.7 | 0.17 | Longan | 0.6 | 1.2 | 0.02 |
| Cotton | 3.9 | 2.7 | 0.13 | Coffee | 0.45 | 0.5 | 0.01 |
| Cassava | 2.1 | 23.0 | 0.07 — | Lemons | 0.4 | 5.2 | 0.01 |
| Sweet potatoes | 1.4 | 12.8 | 0.04 | Mandarin oranges | 0.3 | 1.8 | 0.01 |
| Castor beans | 1.0 | 1.1 | 0.03 | Rambutans | 0.3 | 0.4 | 0.01 |
| Ramie | 0.4 | 0.5 | 0.01 | Oorians | 0.3 | 0.7 | 0.01 |
| | 0.4 | 3.8 | 0.01 | Mangosteen | 0.02 | 0.01 | 0 |
| | | | | Tea | 0.03 | - | 0 |

Table #8: Percentages of transplanted and directly sown wet rice

| Year | 1964/1965 | 1965/1966 | 1966/1967 | 1967/1968 | 1968/1969 |
|---|---|---|---|---|---|
| Transplanted rice | 69.2 | 66.3 | 69.0 | 67.0 | 66.9 |
| Directly sown | 30.8 | 33.7 | 31.0 | 33.0 | 33.1 |

Source: Study of the Agricultural Statistics Dept.

Table #9: Wet rice production volume

| | Planted land area (in 1000s of Ha) | | | Land area harvested vested (in 1000s of Ha) | Harvest volume (in 1000s of tons) | Yield per Ha (in tons) | | Main source of damage to crops crops |
|---|---|---|---|---|---|---|---|---|
| | Rainy season crop | Dry season crop | Total | | | Planted area | Har-vested area | |
| 1964/1965 | 2,245 | 99 | 2,344 | 2,234 | 2,500 | 1.067 | 1.119 | Water damage |
| 1965/1966 | 2,314 | 100 | 2,414 | 2,178 | 2,376 | 0.984 | 1.091 | Drought damage |
| 1966/1967 | 2,350 | 164 | 2,514 | 2,020 | 2,457 | 0.977 | 1.216 | Water damage |
| 1967/1968 | 2,360 | 113 | 2,473 | 2,324 | 3,251 | 1.315 | 1.399 | Drought damage |
| 1968/1969 | 2,303 | 124 | 2,427 | 1,944 | 2,503 | 1.031 | 1.288 | Drought damage |

Table #10: Wet rice varieties utilized (1968/69)

| | Planted area | % of total | Length of growing season |
|---|---|---|---|
| Rainy season<br>Early maturing rice (hatif) | 1000s of Ha<br>87 | %<br>4 | 100-120 days ..Very eary maturing<br>130-150 days ..Eary maturing |
| Half-year rice (mi-saison) | 328 | 14 | 165 days - 185 days |
| Full season rice (saison) | 987 | 40 | 195 days - 210 days |
| Late maturing rice (tardif) | 505 | 21 | 225 days - |
| Floating rice (flottant) | 396 | 16 | 225 days - |
| Sub-totals | 2,303 | 95 | |
| Dry season<br>Early maturing rice (hatif) | 124 | 5 | 90-120 days |
| Totals | 2,427 | 100 | |

Source: Study of the Agricultural Statistics Dept.

2) Routine cultivation methods for wet rice

The cultivation of wet rice in Cambodia is timed to correspond with natural flooding. The main crop of the year is the rainy season crop. It is planted when the rains begin. The grain ears by the time the floods begin to recede and the rice is harvested when the dry season starts.

Planting takes place without fertilization and both seedling transplantation and direct sowing are practiced. (See Tables #8 and #9.) (Direct sowing is practiced in Battambang and Kompong Chhnang Provinces and seedling transplantation everywhere else.) Although rough rice yields in the most fertile areas of the country may be as high as 3 tons per hectare, the national average is a very low 1 ton per hectare.

Some rice is also planted during the dry season after the waters have receded. For this crop, the Boro variety of rice common to East Pakistan is employed. The climate of Cambodia is such that, providing irrigation is in place, it should be possible to plant twice a year during both the rainy and dry season. In fact, considering the climate during the dry season, one could expect even higher yields during the dry season than during the rainy season.

In spite of the careless nature of wet rice cultivation in Cambodia, labor productivity is high. According to Hirano's calculations (for light work, two persons are counted as one in these calculations), the labor force per hectare is 32 persons. Based on a rough rice yield of 1,200kg, per capita per day productivity is 38kg. By way of comparison, in Japan the per hectare labor force is 160 persons. Based on a rough rice yield of 5,100kg in Japan, per capita per day productivity is 32kg. In other words, Cambodia has higher labor productivity in terms of yield than Japan.

(1) The rainy season crop

Planting takes place between May and July and harvesting between December and January.

(Varieties)
Rice varieties employed in Cambodia fall into one of four categories: early maturing rice, mid-term maturing or half-year rice, late maturing or full season rice and very late maturing rice. A fifth category is the so called floating rice. (See Table #10.) These rice varieties are categorized mainly according to photo-period sensitivity, early maturing rice being the most photo-period sensitive and late maturing rice being the least. Since it's a requirement that the rainy season crop be harvested during the dry season (after November) when the waters have receded, for plantings after July, highly photo-period sensitive mid-term through very late maturing rice are planted. These usually require 200 - 250 days to reach maturity, while floating rice needs about 270 days. (See Table #10 and Figure #2.) Rice varieties are not standardized and in many cases farmers themselves don't know the name of the variety they are planting. Plant breeding levels are still at an extremely rudimentary level in Cambodia and the plant breeding effort that does exist is disorganized. It was only under the direction of specialists from Japan that ongoing work was undertaken to gather, categorize and measure the productivity of commonly cultivated native rice species in Cambodia. Recent years have witnessed the introduction

of foreign IR-type rice strains, but these were found to be difficult to cultivate and unsuitable to Cambodian taste.

(How rice is planted)
Seedling transplantation is most common, however in regions where farm operations are on a larger scale, direct sowing is also practiced.

(Plowing and harrowing)
Come the dry season, residual rice stubble in the fields is burned and then farmers wait until the rains come to commence plowing. Most plowing is done with the help of oxen or water buffalo (one or two head). The animal drawn plow functions poorly and efficiency levels are extremely low. It generally takes about a day's work to plow one rai or 1,600 square meters (in fact, farm wages for plowing are calculated according to the number of rai completed). Following plowing, weeding and harrowing take place. This is followed by one or two more passes with the ox-drawn plow. In recent years, the use of tractors has become widespread in Battambang province where farm operations are large scale. It has become common to hire subcontractors with large tractors to handle plowing. Tractor plowing is anywhere from 20 - 30 times more efficient than plowing with oxen. Furthermore, since the cost of tractor plowing is not much more than oxen plowing, the tractor has become a popular alternative. Nevertheless, for poor farmers who do not normally subcontract farm work, it means more debt. (Since poor farmers have little or no capital, plowing costs are deferred until harvest time. Interest accrues, naturally, and the farmer ends up having to pay about twice as much as he would have had he immediately paid in cash.)

(Direct sowing and seedling transplantation)
Under normal circumstances, direct sowing takes place around May and June and seedling transplantation around June and July. Paddy which has not been prepared up to that point will be planted in July and August.

When direct sowing, about 100kg per hectare of seed are broadcast by hand on a drained field which has been plowed and harrowed. Then the oxen pull rakes over the ground to cover the seed. The amount of seed sown is high in comparison to Japan. However, based on the long experience of Cambodian farmers, the large amount of seed sown compensates for haphazard ground preparation and anticipates damage from natural causes like sparrows, rats and flooding. This method of sowing also has something to do with Kopchou to be discussed below.

Since seedling transplantation takes place after the fields have flooded, it's common for the seedlings to be left in the seedling bed for a fairly long time. Although seedlings transplanted young yield highest (according to test results at the Agricultural Center, 25 - 35 day old seedlings are optimal: yields from seedlings which have been left longer in the seedling bed tend to be slightly lower), where cultivation depends on rainfall, farmers may be obliged to delay planting until flooding occurs. It is not unusual, therefore, for the seedlings to be 45 - 50 days old. In such cases, the faded, hard seedlings which are now over 50cm long have the ends of their leaves clipped and are then transplanted. Since the rainy season crop takes a long time to ear, the quality of seedlings is not as much of a problem in Cambodia as it is in Japan.

(kopchou)
This is a field management method peculiar to Cambodia which combines weeding and thinning. When the directly sown wet rice is about 50cm high, the entire paddy is plowed. This is similar to the weeding and thinning technique employed for Aua rice cultivation in East Pakistan. In Pakistan, however, plowing occurs in a dry field when the rice is still young (10 - 15cm in height), whereas the plowing of wet rice in the paddy when the plants are already about 50cm in height is a peculiar characteristic of cultivation in Cambodia. This process is said to submerge and drown weeds, rid the rice plant of small and weak tillers, foster strong plants and prevent the plants from falling over. Essentially, this method has the effect of shallow mid-term plowing, weeding and thinning out.

(Application of fertilizer)
Although fertilizer is usually not applied in Cambodia, in recent years the more conscientious farmers have begun employing fertilizers. By applying 30kg of nitrogen and phosphates per hectare, they have been able to double yields. In addition, the tall stubble which remains after reaping is burned during the dry season and the straw ash allowed to go back into the soil. Although almost no organic matter is added to the fields, sometimes farmers forego burning and opt instead to have the raw stubble plowed back into the earth with a tractor.

(Water management)
Since planting is dependent on rainfall, there is almost no water management during rice growing. Consequently, in years where rainfall is low, the planted area has to be reduced in size. In a serious drought, the entire rice crop may wither and die. On the other hand, if there is too much rain, the seed may rot after sowing and never germinate or the paddy may become submerged. Natural disasters like these are something that the farming population must worry about year after year.

(Damage from plant disease and insects)
In terms of plant diseases, although some rice blast disease (rice blight) is observed, since fertilizer is not utilized in cultivation, the problem is only slight. Although there are many species of potentially harmful insects in Cambodia, the most damaging are the yellow rice and Malay stem borers. However, since stem borers cause only minimal damage during the rainy season, there has been no campaign to eradicate them. Insect damage is most severe during the dry season. (See Figure #3.)

(Rats)
Three varieties of rat are observed: "oninezumi", "kumanezumi" and "hatsukanezumi". However, since the height of the rat breeding season occurs around September during the rainy season when large areas of the country are flooded, the lack of potential rat harborage tends to reduce the population. Rat infestations are therefore only a problem where the flood waters recede early. Rat control measures in Cambodia are minimal and don't go beyond the use of traps or the hunting of rats at night with a fishing spear. It is during the dry season that rats cause the worst damage.

(Harvest)
For reaping purposes, Cambodian farmers use a sickle peculiar to Southeast Asia and cut the rice plants at a height of about 50cm. In terms of reaping efficiency, assuming a yield of one ton per hectare, one man can reap 1 kon or 900 square meters in a day. The kon is the basic unit for measuring reaping work and farm laborers are paid between 40 - 50 riels per kon. The cut grain is gathered into sheaves with a diameter of about 30cm which are stood up vertically in the fields to dry. The sheaves are then carried to the threshing floor (an earthen platform with a hardened surface), located either near the farm house or the fields, where threshing takes place.

Threshing: Threshing is usually accomplished by spreading the sheaves to a thickness of about 50cm on the threshing floor and having three to five head of oxen or water buffalo walk on top of them. Recently, more affluent farm families have been seen using large tractors in place of oxen for threshing.

Yields: Though the rough rice yield will vary from year to year, it averages roughly one ton per hectare. Even in Battambang Province, the country's 'grain basket', with its clayey soil, very few farmers have a yield of over three tons per hectare.

Sorting and storage of rough rice: The threshed rough rice is gathered up, winnowed by hand and placed in burlap bags. These burlap bags can hold anywhere from 60 - 80kg (the standard is 68kg). Once bagged, the rice is sent to market.

(2) The dry season crop

The seed beds for the dry season rice crop are planted in December, transplanted between January and February, and the rice harvested during April and May. The dry season crop is limited to those low lying and swampy areas which could not be cultivated during the rainy season because the waters were too deep, but which retain ground water during the dry season and to areas with access to irrigation facilities. In any case, in terms of the total acreage devoted yearly to wet rice cultivation, the dry season crop constitutes only 4 - 5% of the total yield. (See Table #10.)

Varieties:
Since the dry season crop is planted at a time when the days are getting longer, early maturing varieties (100 -130 days) with low photo-period sensitivity which can be cultivated throughout the year are planted. IR-type varieties have been introduced in recent years and cultivated by the more conscientious farmers. However, these varieties have proven problematic in terms of pest and disease susceptibility as well as taste.

(Transplantation)
The seedlings are transplanted when they are 20 - 50 days old. Unfortunately, planting density tends to be haphazard (between 10 - 13 seedlings per square meter). With the low number of grain ears as a result of this low density planting practice, yields cannot be expected to rise. Furthermore, planting is normally deep.

(Application of fertilizer)
Cultivation normally takes place without the application of fertilizers. The application of fertilizer is much more common during the dry season than during the rainy season. First of all, the work of applying fertilizer is easier during the dry season. Secondly, the IR rice varieties that have been introduced in some places require fertilization to thrive.

(Weeding)
Weeding is almost exclusively done by hand, but weed management is grossly inadequate and weed growth is extensive.

(Damage from plant disease and insects)
Currently, damage caused by plant disease doesn't seem to be a very big problem. Damage from several varieties of stem borers, however, is massive. This has to do with the life cycle of stem borers in Cambodia. Since the moth phase of the life cycle peaks between November and January, in some instances larvae may already be observed on seedlings. And, since the area planted during the dry season is extremely small, the stem borers congregate in large numbers there. (See Figure #3.) Where no measures are taken to safeguard the dry season crop from stem borers, in some regions the harvest may be almost completely destroyed. Even when the culm and primary tiller have been completely destroyed by stem borer infestation, there are some rice varieties which rapidly put out higher order tillers which subsequently bear grain and can be harvested at maturity.

(Rats)
Depending on the location, crop damage by rats can be extremely severe -- to a degree quite unimaginable, in fact, in Japan. The rats which were without harborage during the rainy season, acquire tremendous harborage when the waters recede. What's more, the large amounts of rough rice which fall to the ground as a result of shattering when the rainy season crop is harvested provide abundant food leading to serious rat infestation. (Native species of rice in Cambodia are particularly prone to shattering and lost grain is calculated at 100kg per hectare.) During the dry season, the rats may even damage the seedling beds. The rice may also be damaged in its early growth stages in the paddy by rats. The damage caused by rat nibbling during the spikelet formation phase in the rice plant is the worst. Again, if no countermeasures are taken against rats, there may be no harvest. Damage caused by rats seems to vary considerably from place to place. At some locations, damage caused by rats is not a problem. The reasons for this variance are not well understood.

(Water management)
Apart from the rice planted in swampy, lowland areas, the dry season crop needs irrigation. A variety of methods are utilized: hand irrigation (a bamboo basket with a length of rope attached to both ends is lowered into water, filled and pulled up by two people); the foot-operated water wheel, water wheel irrigation (the water wheel raises the water and it is fed into bamboo piping on both sides of the wheel); and motorized pump.

(Harvesting and other processing)
The same methods as those applied during the rainy season.

### 3) Problem points with respect to wet rice cultivation in Cambodia

#### (1) Irrigation facilities

It is said that power is his who best controls water. It is also said that the effective utilization of water resources has had a tremendous influence on cultural development. This is certainly true of Cambodia and the other countries of Southeast Asia which are in the monsoon region. In spite of the fact that the region undergoes extensive flooding during the rainy season, almost none of this tremendous volume of water is used during the dry season. Ironically, the dry season brings a water shortage which proves a major barrier to wet rice planting. The most significant barrier to wet rice production in Cambodia as a whole during the dry season is the poor state of its irrigation facilities. This lack of serviceable irrigation facilites means that wet rice planting and production are at the mercy of the volume and distribution of natural rainfall. This is a potentially destabilizing factor which affects rice production every year.

In Cambodia, one finds the Prai Occidental irrigation pond which was constructed a millenia ago during the Angkor Period. Having fallen into disrepair, it was repaired with American assistance and has the capacity to irrigate an area of 1,200ha. It remains, however, underutilized. In 1957, the Lower Mekong Region Survey Committee (nicknamed the Mekong Committee) was established under international auspices. Focusing on Cambodia, the survey endeavored to draw up development plans for two main rivers, the Sambor and Tonle-Sap and four branch rivers, the Battambang, Prek Thnot, Stung Pursat and Stung Sen. With the survey now complete, some construction is already underway. Hopes are high that these hydraulic projects will eventually make it possible to irrigate some 322,000ha. When it announced its Agricultural Development Policy in 1968, the Cambodian Government cited a haphazard water utilization policy as a factor hampering agricultural development. The Cambodian Government has placed a priority on the implementation of small-scale irrigation projects and gradual progress in irrigation can be observed. In terms of the agricultural development of Cambodia, this is all good news.

Water utilization policy of itself will neither increase wet rice production nor insure the introduction of double-cropping. This will only be possible if cultivation technology is developed in tandem with water resources. Nevertheless, there is no question that the establishment of ample irrigation and drainage facilities would increase wet rice production and stimulate rapid development of Cambodian agriculture.

In terms of the cultivation technology required, research should be undertaken as quickly as possible in the following areas: water resources management technology (including quantitative assessments of the water resources required), the selection and breeding of better rice strains, fertilizers, measures to combat plant disease, harmful insects and rat infestation, and crop rotation systems.

#### (2) Cultivation without fertilizers

The application of fertilizer is an important factor in boosting rice production. Nevertheless, fertilizers are generally not used in

Cambodia. According to Projected Fertilizer Supply and Demand for Cambodia as forecast by that country's Ministry of Agriculture (Table #11), a mere 1,252 tons of urea and ammonium sulphate were consumed by Cambodian agriculture in 1965. Furthermore, these fertilizers were not principally employed for the rice crop but for vegetable farming. Although 10,860 tons of urea are slated for consumption in 1970 according to these same statistics, at 60kg of urea per hectare, this amounts to fertilization of only 180,000 hectares, or 8% of the total area planted in wet rice. The Cambodian Government projects that 1975 fertilizer consumption will be three times that of 1970 and that fertilizers will be applied to all wet rice paddies in Cambodia by 1985. These projections are probably too optimistic. (See Tables #11 and #12.)

Test results obtained at the Agricultural Center show conclusively that the application of fertilizer increases the rough rice yield. Furthermore, income studies ('The 1968 Rice Crop in Cambodia' by Hatta Sadao) also clearly show that the use of fertilizers increases household earnings. Unfortunately, however, fertilizer prices in Cambodia are high in comparison to the price that farmers get for rough rice. Consequently, without increased government subsidies for fertilizer, the promotion of fertilizer use in agriculture cannot be expected to gain much more ground.

In terms of fertilization techniques suitable to Cambodia, test results obtained at the Center have shown that although potassic fertilizers may not be necessary, the application of 60kg of phosphatic fertilizer per hectare is indispensable. In addition, 30 - 60kg per hectare of nitrogenous fertilizers -- this can be in the form of manure applied before sowing -- can raise yields to 3 - 4 tons per hectare. Even phosphatic fertilizers all by themselves can be expected to raise the yield to over 2 tons per hectare. If nitrogenous fertilizer alone is to be used, it is best to apply it about ten days prior to spikelet formation. Although this method, too, can be expected to increase yields, the safest bet is to combine fertilizers by augmenting the manure base with phosphatic fertilizer. It should always be kept in mind that plant response to fertilization will differ according to the variety of rice in cultivation. Before drawing up a fertilizer application plan, the special characteristics of the variety of rice in cultivation should be carefully studied. In general, native rice species tend to lose their erectness when they are subjected to heavy nitrogen fertilization and have a low yield response when large quantities of nitrogenous fertilizer are applied. Finally, in fertile areas with rough rice yields of over 3 tons per hectare where cultivation is conducted without fertilizer, the application of fertilizers has been shown to be without notable effect.

### (3) Weeding

Weeds are eliminated from the directly sown rainy season crop by means of Kopchou and the maintenance of high water levels in the paddy. These unique methods of weed control are a natural outgrowth of cultivation which relies on rainfall and there are presently no new breakthrough weeding methods on the horizon that might replace them. (Weed killers are undesirable in the paddies because they are poisonous to fish.) However, assuming the introduction of adequate irrigation and drainage facilities which would make it possible to truly control water, the safe use of weed killers would theoretically be possible. If dry field conditions could be introduced when the rice is in its early growth stages, methods like blind weeding and/or shallow mid-term plowing to remove weeds might be introduced. For the dry season crop, adequate weed management by such means as mechanical weeders is desirable for the time being, but the most appropriate solution for the future would be weed killers.

(4) Damage from plant disease and insects

Although plant disease is not currently a problem, crops in neighboring Thailand have been afflicted with orange leaf virus and serious thought needs to be given to implementing countermeasures in Cambodia. In terms of harmful insects, stem borers are a problem, with damage particularly severe during the dry season crop. There are only two methods for combating stem borers; one is to spray with insecticides and the other is to shift planting dates. However, the high cost and scarcity of insecticides in Cambodia put them out of the reach of poor farmers as a solution to this problem. Shifting planting dates is difficult to accomplish in regions where a rainy season crop is planted because doing so may adversely impact the subsequent rainy season crop. However, in regions where only a dry season crop is planted, if attention is paid to flood timing, it is relatively easy to shift planting dates as a means of combating stem borer infestation. Another important approach to combating stem borers is the breeding of stem borer-resistant strains. Another potential solution would be to increase the area of the dry season crop so that the stem borers would be more dispersed and cause less damage to crops.

(5) Rat prevention

Although damage to the rainy season crop by rats is small thanks to the presence of flood waters which disperse them, rats can inflict terrible damage on dry season crops. Consequently, where dry season crops are introduced in regions which have traditionally only had a rainy season crop, planting a dry season crop may be an exercise in futility unless effective rat and stem borer prevention measures (as discussed above) are in place.

Although no low cost, economical means of rat prevention have been found as yet, if we ignore the question of economy, the following prevention countermeasures might be tried

a) Construction of electric fences
By surrounding the paddy with a wire netting and running a current of 200 - 300V through it, invading rats would be killed by electric shock. This would completely stop rats from invading the field. Though this method requires both materials and a source of electrical current, it is being employed in test fields.

b) Surround the field with galvanized steel sheets
Where no source of electrical current is available, the paddy can be surrounded with 50cm-high sheets of galvanized steel sheet or slippery plastic. Although this method can effectively prevent any rat intrusion, the cost of materials is very high and it may not be practical outside of test fields.

c) Poisoned bait

Poisoned rat bait is another alternative. At present, however, although this method may kill some rats others will get through and damage the crop. Eliminating rat harborage as a means of reducing rat populations has been explored, but it would not be feasible in Southeast Asia. On other fronts, research is underway to see if rat populations can be eliminated by administering contraceptive agents which prevent them from breeding.

The problem with poisoned rat bait is that it may be consumed by and cause harm to domestic and wild animals. When poisoned bait was used to kill wild animals causing serious damage to the maize crop at the Maize Center, local farmers were said to have been alarmed by the practice.

(6) Problems relating to the use of agricultural chemicals

All kinds of data have been obtained on the effectiveness of agricultural chemicals. However, as long as such chemicals have toxic properties, the question of introducing them into Cambodian agriculture requires careful study and judgment.

Cambodian farm villages commonly have neither wells nor plumbing of any kind. Farmers get their water for drinking and other purposes from the flood waters near their homes during the rainy season and from collection ponds and rivers during the dry season. Consequently, it must be remembered that any toxic substances finding their way into this water supply will have a direct impact on the lives of human beings and animals.

The flood waters of the rainy season support the breeding and growth of all kinds of fish. Regardless of whether we're talking about rice paddies or rivers, wherever there is water in Cambodia you find fish in abundance. This supply of fish is an important auxiliary food source (protein) for farm people. Consequently, any toxicity which accumulates in the fish population will impact human health. Levels of toxicity high enough to kill the fish population would have dire consequences for the farm economy.

As for insecticides, although there are pest problems (as yet unresearched), once chemical agents come into use they begin to accumulate in the environment with corresponding increases in toxicity. Quite apart from economic considerations, the question of insecticide use needs to be approached with extreme care.

Rice straw is an important source of feed for the cattle (raised for food purposes).

第 2 図

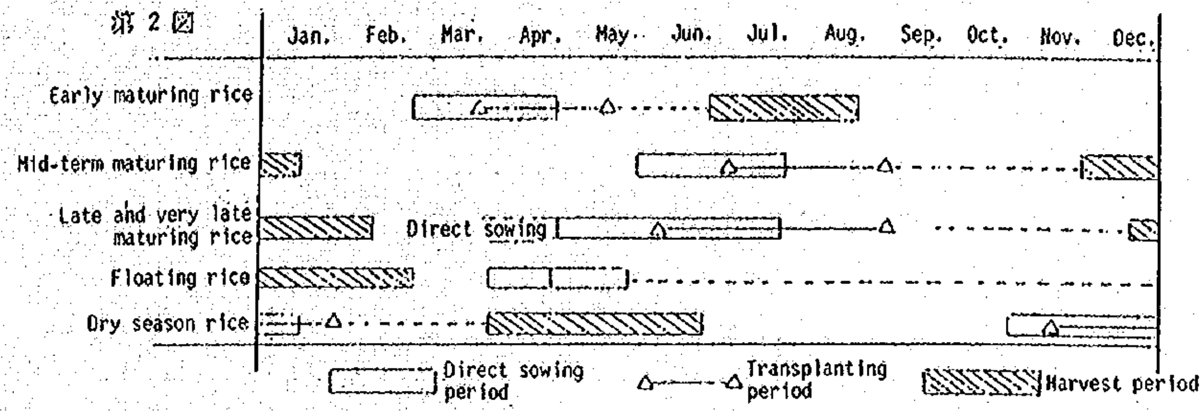


Figure #1 Planting schedule for the varieties of rice cultivated in Cambodia (according to Yatta)

Note)
1. Early maturing rice is often directly sown. The direct sowing period is the same as the transplanting period. This variety is planted in regions where flooding is relatively early and farmers need grain to tide them over during the lean period between harvests.
2. The direct sowing of late and very late maturing varieties takes place when the rains begin to fall in April and the ground has softened.
3. All floating rice is directly sown.

第 3 図

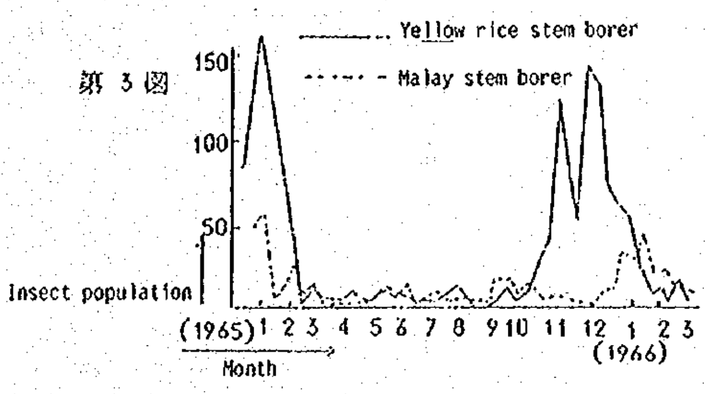


Figure #8: Numbers of yellow rice and Malay stem borers gathered with a luring lamp (based on statistics by an overseas technical cooperation organization)

Table #11: Projected Fertilizer Supply and Demand in Cambodia

| Year | Urea and ammonium sulphate | Double super phosphate |
|---|---|---|
| 1965 (actual results) | 1,252.5 t | - t |
| 1970 | 10,860 | 21,720 |
| 1975 | 32,580 | 65,160 |
| 1985 | 138,000 | 276,000 |

Source: December 1965 Projections of the Cambodian Ministry of Agriculture

Table #12: Actual use of chemical fertilizers

|  | Nitrogenous fertilizers | Phosphatic fertilizers | Potassic fertilizers | Other fertilizers |
|---|---|---|---|---|
| 1966 | 1,404 t | 11,259 tons | 303 tons | 280 tons |
| 1967 | 3,173 | 12,669 | 47 | 1,187 |
| 1968 | 4,392 | 17,364 | 303 | 791 |

Source: Research by the Statics Department of the Agricultural Affairs Agency

Table #13: Wet rice production statistics by region

| Region | | Surface area planted (A) | Damaged surface area (B) | B/A | Surface area harvested | Yield | Yield per harvested tan | Yield per planted tan |
|---|---|---|---|---|---|---|---|---|
| | | ha | ha | % | ha | t | t | t |
| Hattambang | | 440,130 | 220,450 | 50 | 219,680 | 194,450 | 0.884 | 0.442 |
| Prey Veng | | 281,400 | 16,850 | 6 | 264,550 | 430,760 | 1.628 | 1.531 |
| Siemreap | | 253,660 | 30,060 | 12 | 223,600 | 219,920 | 0.983 | 0.867 |
| Takeo | | 219,900 | 14,030 | 6 | 205,870 | 254,780 | 1.237 | 1.159 |
| Svay Rieng | | 183,770 | 110 | 0 | 183,660 | 226,830 | 1.235 | 1.234 |
| Kompong Cham | | 190,160 | 7,530 | 4 | 182,630 | 339,570 | 1.859 | 1.786 |
| Kampot | | 160,650 | 28,140 | 17 | 132,510 | 134,860 | 1.017 | 0.839 |
| Kompong Thom | | 160,620 | 83,310 | 51 | 77,310 | 62,510 | 0.808 | 0.389 |
| Kompong Speu | | 136,280 | 31,340 | 22 | 104,940 | 122,920 | 1.171 | 0.902 |
| Kompong Chhunang | | 111,520 | 7,800 | 7 | 103,720 | 116,750 | 1.131 | 1.047 |
| Kandal | | 122,720 | 35,890 | 29 | 86,830 | 123,060 | 1.465 | 1.003 |
| Pursat | | 101,200 | 5,100 | 2 | 96,100 | 181,530 | 1.888 | 1.794 |
| Rattanakiri | | 6,950 | 30 | 0 | 6,920 | 11,480 | 1.660 | 1.652 |
| Kratie | | 21,710 | 680 | 3 | 21,030 | 55,150 | 1.671 | 1.619 |
| Koh Kong | | 9,980 | 10 | 0 | 9,970 | 14,130 | 1.416 | 1,416 |
| Preah Vihear | | 12,000 | - | - | 12,000 | 16,510 | 1.376 | 1.376 |
| Stung Treng | | 7,500 | 1,480 | 19 | 6,020 | 6,350 | 1.057 | 0.847 |
| Mondulkiri | | 6,460 | 260 | 4 | 6,200 | 10,820 | 1.746 | 1,675 |
| Kirirom | | 620 | 100 | 15 | 520 | 650 | 1.249 | 1.048 |
| Totals | | 2,427,000 | 483,000 | 20 | 1,944,000 | 2,503,000 | 1.288 | 1.031 |
| Break-down | Rainy season crop | 2,303,000 | 477,000 | 21 | 1,826,000 | 2,293,000 | 1.255 | 0.996 |
| | Dry season crop | 124,000 | 6,000 | 5 | 118,000 | 210,000 | 1.781 | 1.694 |

Note: 1. Source: 1968-69 Annual Report of the Statistics Department of the Agricultural Affairs Agency
2. The 1968-69 rainy season rice crop was badly damaged by drought. Damage was particularly severe in Battambang and Kompong Thom provinces.

## II. Summary of the duties performed at the Center

### 1. Objectives and duties of the Center

As a friendly gesture in response to the Cambodian renunciation of wartime compensation claims on Japan and in accordance with the Khmer-Japanese Economic and Technical Cooperation Agreement signed on March 2, 1959, the Khmer Japanese Friendship Agricultural Technical Center, along with an animal husbandry center and medical clinic, were established with a 1.5 billion yen grant from the Japanese Government.

Due to time-consuming construction, it was not until July 1964 that the Japanese technical staff was actually posted and the testing and research activity of the Center got underway. Certain sections of the facility remained to be completed, however, and it was not until August 1965 that opening ceremonies, presided over by Prince Sihanouk himself, were held.

With the period of cooperation stipulated in the Technical Cooperation Agreement scheduled to end on July 5, 1966, bilateral discussions were held and a joint communique issued extending the period of cooperation by three years starting October 1, 1966.

In March, 1969 the Japanese Government dispatched a survey team to Cambodia to examine activities at the Center. The survey team recommended that the cooperative effort be continued. A second joint communique was subsequently issued extending once again the period of cooperation, this time by two years, beginning October 1, 1969.

According to the joint communique issued by the Cambodian and Japanese Governments, the objectives of the Center are as follows:

(1) To conduct testing, research and surveys designed to raise the level of agricultural production technology.

(2) To provide additional technical training for Cambodian agrarian engineers and popularize technology among the farm population in general.

(3) To increase agricultural production and exhibit experimental displays designed to teach farmers how to increase agricultural production.

In line with these objectives, the Center will carry out the following duties:

(1) Conduct testing, research and surveys relating to the production technology of rice and other field crops.

(2) The production and distribution of superior seed stock .

(3) Research and surveys relating to the use of farm tools and machinery.

(4) Train technicians.

(5) Technical training for farmers.

(6) Exhibit experimental displays of improved rice crops.

Since wet rice is the single most important crop in Cambodia, the thrust of the Center's efforts are focused on this crop. Cultivation testing for the selection of sugar cane varieties and vegetables (garlic, onions, eggplants, tomatoes, etc.) is also going on, but this work is tangential in comparison to the focus on wet rice.

In terms of testing and research on wet rice, the plant breeding phase of work is almost complete. This phase includes the collection of native species and survey work to record the special characteristics of each variety. The ongoing work in this area is currently focused on the selection of superior varieties from among the native species and testing designed to certify the productivity of these varieties. At present, the most promising varieties are being selected. For technical training purposes, some selection of crossbred hybrids is also being done.

With respect to fertilizers and cultivation, testing to determine the amounts and optimal times for fertilizer application, testing to determine optimal planting methods (including direct sowing) and plant density, testing to determine optimal planting times and seedling age, and testing on mechanized cultivation are being conducted. Furthermore, in addition to analyses of domestically produced phosphatic fertilizers and testing of fertilizer effectiveness, the Center is also in the process, albeit fragmentarily, of conducting soil surveys in the various regions of the country. The Center, for its part, is located in a region where the soil is a clayey lake alluvium. However, in order for the Center's test results to be applicable in local (i.e. other) areas, additional testing in the soil of those areas is essential. The soil survey is viewed as an important preparatory step in this process.

With respect to plant disease and harmful insects, the testing of prevention methods and insect lifecycle surveys are being conducted. Since diseases and insects do not seriously damage the rainy season crop, a plant disease and pest specialist was not dispatched from Japan this time.

Due to the serious damage to dry season crops caused by rats in recent years, meaningful results were unobtainable. (Technical staff from the Tropical Agriculture Research Center were dispatched to the Center to work on rat prevention. They did research on rat ecology and tested poisonous bait.)

With respect to seed production, owing to the fact that superior varieties have yet to be identified and production fields are not yet serviceable, practical work in this area has yet to begin. These tasks should be accomplished, however, sometime during the current two year period.

Although the Center is equipped with classrooms and dormitories to facilitate the training of technicians, the remote location of the Center has made it difficult to attract participants. As a result, no training work is underway at present. (Student dormitories are being used at the moment to house day laborers.) Consequently, only the Cambodian staff at the Center is receiving instruction from the Japanese technical staff in the course of routine testing and research.

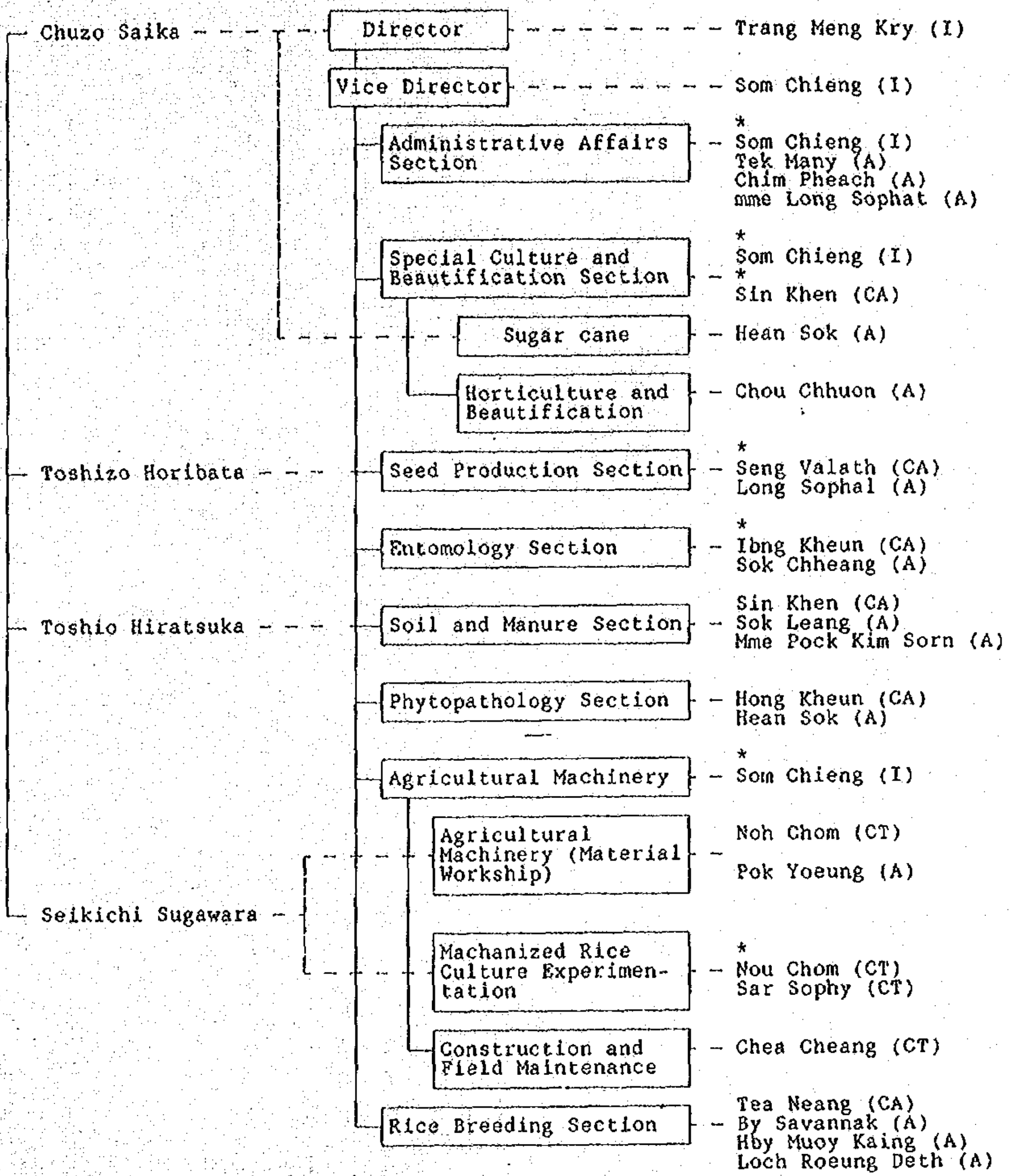
As far as the testing of improved rice varieties goes, during the tenure of Group Leader Hirano Toshio, the Center managed to achieve an extremely high 10 ton per hectare yield using the IR-8 Variety. Although this was quite an achievement, from the testing and research perspective at least, the technical means and know-how for obtaining such high yields are well beyond the level of Cambodian farmers, which is why little local interest was shown in the results. Later, it was thought that test fields used to determine optimum fertilizer quantities and application timing could serve as experimental display fields and that fertilizer combination testing conducted at various National Agricultural Testing Centers in accordance with directives of the Central Government could, likewise, serve a display role in the various regions of the country. The effectiveness of such display efforts, however, remains unclear. In terms of displays over a wide geographical area, display fields showing cultivation with fertilizers were established on family farms under the auspices of public education organizations in the various provinces. Again, it is unclear as to whether these displays were effective or not.

During the 1970 rainy season, the Center set up a display field to show mechanized direct sowing and cultivation. A field at the Center adjacent to the National Highway was chosen for the purpose. Unfortunately, 1970 was a year of high floods and lying as it did on the outer perimeter, this field suffered extensive damage at high water and was not ultimately usable for display purposes.

2. The organization of the Center and policies relating to the duties of the Japanese technical staff

The Center has been established to carry out the duties described above and is organized as shown below.

Organization of the Agricultural Center (as of Oct. 1969)



Note: I .... Agricultural Expert
CA ... Agricultural Supervisor
CT ... Rural Affairs Supervisor
A .... Person in Charge of Culture

With the transfer of Director Trong Meng Kry to the Agricultural Affairs Agency on April 1, 1970, Assistant Director Som Chieng assumed the directorship of the Center. As of this writing (early June, 1970) the post of Assistant Director has not yet been filled.

What was surprising once work had begun at the Center, was the lack of motivation among Cambodian staff members to do independent research. This problem came into clearer focus during the process of formulating the 1970-71 Testing Plan. Cambodian staff members were told that the Testing Plan for the following year had to be drawn up and then encouraged to work as specialists in presenting a plan. In other words, the Cambodian staff was put in unconditional charge of the project. In trying to figure out why the Cambodian staff was so apathetic, it was pointed out that, on discovering the low level of competence among the Cambodian staff, the previous Japanese technical staff had decided to conduct all research and testing on its own. As a result, the Cambodian staff was relegated to the status of helpers to the Japanese technical staff. This helps to explain why the Cambodian staff never developed independent work habits and why their motivation has remained so low.

In order to raise as rapidly as possible the extremely low levels of Cambodian technical competence, the previous supervisorial policy was probably viewed as an inevitable transitional expedient. They first wanted to show the Cambodian staff samples of properly organized, modern testing and research. These samples could be employed as tools not only to teach the Cambodian staff ideal methods of testing and research, but also to motivate them. We need to break away from practices like these as quickly as we can. Finally, in light of the strong sentiments on the Japanese side to conclude the extended period of cooperation early this time, the upgrading of Cambodian technical competence is all the more pressing.

In order to quickly transfer the skills which will allow the Cambodians to stand on their own feet, we have placed a strong emphasis on strengthening the independence of the Cambodian staff, given the Cambodian staff full responsibility for the planning, design and conduct of all tests, and instituted a policy whereby the members of the Japanese technical staff cooperate with their Cambodian counterparts in the capacity of advisers. Working with Cambodian counterparts whose levels of technical competence are still low and who lack experience and motivation, the adviser posture of the Japanese staff has meant closer contact with their Cambodian counterparts than ever before. For instance, whereas the Japanese technical staff used to gather together in classrooms to study, nowadays they are studying together with their Cambodian counterparts. Furthermore, there is a strong emphasis on things like how to carry out planning and how to apply more advanced technological methods. The instruction the Cambodians receive is based on close one-on-one daily contact with members of the Japanese technical staff. In spite of the fact that expectations are not very high with respect to test results for next year, emphasis has shifted from sophisticated test results to assisting the Cambodian staff in upgrading its technical competence levels.

The Cambodian staff which has for the first time been given full responsibility for the 1970-71 Testing Plan has made full use of its competence and, however elementary, put together a textbook test plan. What we have achieved with our new 'adviser' posture should be viewed as a development process which is built on the educational efforts of the Japanese staff members who preceded us at the Center.

## 3. Description of facilities at the Center

The Center lies 33km beyond the city of Battambang on National Highway 5. (Battambang City lies 300km north-northwest of Phnom Penh, the capital of

Cambodia, likewise along National Highway 5.) Located on a rectangular parcel 1,000m x 3,000m, the Center has a total area of 300ha. The main building, warehouses, dormitories and other Center facilities take up about 20ha of the total and the remaining 280ha are fields.

Although dykes, arterial roads and waterways are all in place adjacent to the fields and the fields have been subdivided (into 15ha parcels), some of the fields are still without paths or secondary waterways. In particular, progress lags with respect to drainage and field leveling. About 40ha of test field have been set up. During the 1969 rainy season, seven fields (or about 105ha) remained unplanted, while many fields which were placed under cultivation had not been completely leveled. Although excavation of drainage ditches was begun during the dry season, with only one aging and frequently broken backhoe, operational efficiency was low. With the coming of the rainy season this work had to be interrupted. Under conditions like these, a considerable amount of additional construction work will be required before we are truly in a position to irrigate and drain fields freely.

In terms of water for irrigation, a branch channel from the Popel water supply has already been completed. Furthermore, repairs were done on the branch channel in April 1970 so that, pending authorization from the Provincial Waterworks Office, the Center should have free access to water whenever it is needed. Consequently, as long as the Popel water supply is available, double cropping should be possible.

With respect to farm machinery, there are a considerable number of large and small Japanese-made farm machines available. Since the fields at the Center are large, the large machinery has been heavily utilized -- with the inevitable accompanying heavy wear. The trucks and jeeps in use at the Center have, likewise, been subjected to heavy wear. (See the separate Table entitled 'The Current State of Farm Machinery' on page __.) On the 1969 Equipment and Materials Purchase Order, replacements for worn equipment and repair tools were requested. In fact, these replacements and tools were deemed essential to get the Center through the 1970 rainy season. However, the ordered equipment was never sent, thereby causing problems with the implementation of the 1970 rainy season crop.

With respect to test apparatus, a considerable amount of equipment is on hand. At the current stage of testing, there are no serious obstacles to work in this area.

With respect to electricity and plumbing, the Center generates its own electricity. Due to lack of fuel, however, the generator only operates for 9 - 10 hours per day. The 9 - 10 hours of electricity every day are scheduled to facilitate living necessities. Electricity is generated for two hours in the morning to facilitate the preparation of breakfast, for two hours at the noon hour for lunch preparation and then for five hours, from 6 - 11pm, each evening. What this means, of course, is that very little electricity is supplied during work hours. The plumbing system is driven by a pressurized tank which pushes water through the system. Consequently, the plumbing does not work when there is no electricity. With this setup, it is very difficult to perform chemical analyses smoothly during regular work hours.

During the rainy season, the plumbing system is fed by standing water and during the dry season water is drawn from the Popel water supply. In either case, the water is muddy. Due to the sizable mud accumulations in the sedimentation tank, unless the mud is constantly removed, the water in the plumbing system will be turbid. Water turbidity is especially severe during the dry season when the 2m deep sedimentation tank will fill up in the space of one week if not attended to. In an effort to conserve sulphate alumina, the Cambodians have been slack in removing mud, a situation which has tended to lead to differences of opinion with the Japanese technical staff. (This problem was only exacerbated during the 1970 dry season when ??sulphate alumina was in very short supply.)

4. Description of the testing and research process

1) Plant breeding

a) Introduction of new varieties

Varieties from Japan (Honen sosei, Shonishiki) and Taiwan (Chianan 242, Tainan No. 3 and Taich'u No. 65) were introduced during the 1964-5 season. Regardless of high yield potential, however, these varieties require a high level of cultivation technology and were not that appealing to Cambodian tastes. Varieties from India posed problems with respect to the length of growing season. In 1966, IR-8 and IR-5 were introduced and these are being established for the time being on a test basis. Their suitability in many categories -- Cambodian tastes, fertilization, resistance to plant disease and pests, irrigation requirements, etc. -- has yet to be ascertained.

b) Plant breeding tests

A considerable amount of effort is going into plant breeding. With the arrival of a Japanese plant breeding specialist (Sakaguchi Susumu who served from March 1967 - March 1969), work was begun from scratch to gather native rice species, record their special characteristics and grade productivity.

From among the five hundred odd native rice species, four hundred were studied and categorized morphologically on the basis of 35 phenotypes. Those native species judged superior were then selected.

2) Cultivation

a) Testing relating to seedling growth period (no. of days)

In tests designed to correlate the length of the growth period (no. of days) in the seedling bed and yield, results showed that 20 - 35 day old seedlings were optimal.

b) Testing to determine optimal planting methods

Testing was conducted in order to compare random hand sowing, row sowing and seedling transplantation. Results showed that seedling transplantation produced the highest yield, followed by row sowing and random hand sowing. In terms of direct sowing as a planting technique, row sowing was shown to be superior to random hand sowing. Furthermore, during testing to ascertain optimal planting density, a density of 22.2 - 26.6 plants (or plant clumps) per square meter was shown to produce the highest yields. Any more or less, it was found, would reduce yields.

c) Testing to ascertain the viability of double cropping

IR and other varieties were employed for the dry season crop in 1966-67 and meticulous care lavished on cultivation. This round of testing verified that it is possible to achieve milled rice yields of around 10 tons per hectare with IR-8.

It had been previously verified that, with attention to the three points for improving rice crops -- something the Center has been trying to promulgate -- namely, water management techniques, rice variety and fertilization, that even native species could render a milled rice yield of 3 tons per hectare.

Finally, consideration was also given to factors such as the number of plants planted and responsiveness to nitrogenous fertilizer both of which bear heavily on yields.

d) Research on dormancy characteristics

Native rice species are reported to have a rather long dormancy period which becomes a problem when seed stock from the rainy season harvest is to be used for the dry season crop. Seed dormancy can be effectively overcome, it has become clear, by a dry heat treatment whereby seed stock is maintained at 60xC for a period of 100 hours.

e) Research on broken grain

Prevention of grain breakage means higher quality rice. It is an important problem that is being researched at the Center. Once the moisture content of the rough rice drops below 17%, the quantity of broken rice will have a tendency to increase. It has also been ascertained that the drying method employed will occasion differences in the quantity of broken kernels (head yield). For instance, sheaves of rough rice which are stacked in the field and left to stand will have a broken kernel rate of 40 - 45% after ten days. In contrast, the broken kernel rate of rough rice dried in the shade will not exceed 3%, even after fifteen days of drying.

Although the question of when to harvest will vary according to the variety in cultivation, study shows that head yield decreases (i.e., the broken kernel rate increases) in grain that is harvested more than 45 days after earing.

f) Research on shattering (and shedding)

Since the Indica race is particularly prone to shattering, the shattering (and shedding) rates of native species in Cambodia are being researched. It is estimated that about 10% of the harvest is generally lost due to shattering.

g) Testing water-conserving cultivation

Studies have been conducted to determine the possibility of economizing on water for the dry season crop and measure the actual quantities of water required. Like rice cultivated in Japan, irrigation for the

Cambodian rice crop is most crucial between the time when spikelets form and earing. Furthermore, reducing the water supply during other phases of development will not impact yield. In point of fact, the key to increased yields is not so much irrigation as soil condition and management. If we disregard for the moment water lost through absorption in the waterways, intermittent as opposed to constant irrigation can mean a 40% reduction in required water resources with no reduction in yields.

3) Soil and fertilizers

a) Testing to determine optimal quantities of fertilizer

Testing with varying quantities of nitrogenous, phosphatic and potassic fertilizers which included base and supplementary applications was conducted. Strictly from the standpoint of high yield, the following per hectare amounts were deemed necessary: 100 kg of nitrogenous fertilizer, 100 kg of phosphatic fertilizer and 50kg of potassic fertilizer.

b) Testing to compare the effectiveness of different (particularly phosphatic and nitrogenous) fertilizers

Testing was conducted on various kinds of nitrogenous fertilizer, combination fertilizers and special fertilizers. In addition, control test fields were prepared where cultivation took place with one of the three main fertilizers missing in order to gage the impact on yield which each fertilizer type has. It was reported that phosphatic fertilizer impacts yield the most, followed by nitrogenous and then potassic fertilizer. According to a subsequent report, the biggest factor affecting the yield of rough rice is soil nitrogen. In this instance, one could postulate that phosphatic fertilizers applied for previous crops were still exerting a residual effect when the testing for this report was conducted. Finally, yields can be doubled and tripled without applying any potassic fertilizers.

c) Testing to promote soil fertility with the application of organic materials

In the interests of promoting soil fertility, analyses were conducted to ascertain the effectiveness of various green manure crops, especially autotrophic legumes. Tests confirmed that green manure crops contain considerable nitrogen. (Ho Tong Lip reports that Eupatorium odoratum L. is a rather effective green manure crop.)

d) Testing the effectiveness of domestically produced nitrogenous fertilizers

Since 1965, testing has been conducted to determine the effectiveness of phosphatic fertilizers, the type considered most crucial to cultivation in Cambodia. Later, analyses and field testing of phosphatic fertilizers produced in various regions of the country (Tuk Meas and other areas) were conducted and domestic fertilizers found to be both effective and practical.

e) Analysis of irrigation water

Japanese technicians were performing water analyses in Cambodia even before the Center was established. The results of potassium and lime analyses performed at 18 sites throughout the country were reported on in 1966.

f) Other topics

(1) Bronzing tests

Bronzing is a problem which occurs throughout Southeast Asia. Possible causes of this problem, such as fertilizers, the introduction of foreign topsoil, nematode removal, etc. are being pursued.

(2) The chemical analysis of soils along Cambodia's National Highways

Samples from ninety sites adjacent to National Highways throughout the country have been analyzed for PH, soil constituents, substitution capacity, alkaline saturation, humus content and C/N ratio.

As a preparatory survey leading up to 1970 rainy season testing, six sites in the country's main regions were selected and a soil profile and chemical analysis performed. Due to the outbreak of hostilities, however, only PH and phosphate quantities could be measured and nitrogen and potassium measurements were not completed.

4) Plant disease and harmful insects

a) Plant disease

Research and testing of rice plant diseases...
Testing was done on the incubation conditions and eradication of rice blast disease (rice blight) in tropical regions. A meaningful difference in yields thanks to the effect of chemical agents employed in the fields could not be confirmed.

A study of sheath blight when this disease flaired in 1965 demonstrated that it can cause considerable yield reductions. This study confirmed the importance of applying chemical agents to combat it.

Bacterial leaf blight occurs both in native species and introduced varieties of rice, alike. Separation and culturing of the bacteria which causes this disease have shown that it belongs to a pathogenically strong strain. Searches are being conducted on parasitic plants apart from rice to ascertain whether infection may be coming from other sources.

In terms of the plant diseases which occurred in 1965, rice blast disease and seedling blight were observed in seedlings. After transplantation to the paddy, the occurrence of rice blast disease, sheath blight, "monkarebyo blight", bacterial leaf blight, an unidentified bacterial disease, core breakdown caused by "Midorimushi" and other diseases was observed.

Later, in 1967, a disease which caused the tips of 1 - 3 leaves on the young seedling to wither was discovered (by a Japanese technician named

Nemoto) and classified as dry rot.

b) Harmful insects

Stem borers...
A detailed study of the insect pests which plague the rice plant in Cambodia would reveal a list of over 150 insect species. Among these, the damage caused by stem borers -- rice stem borer, yellow rice stem borer and Malay stem borer -- is particularly serious. Testing to eradicate stem borers with multiple field applications of chemical agents was conducted using Fenitrothion. Two to three applications were shown to reduce the number of infested stems and increase yield.

Using a luring lamp to attract and gather stem borers, it was found that the yellow rice stem borer population was largest followed by the Malay stem borer. There was an extremely low occurrence of the rice stem borer. In a study conducted between January 1965 and March 1966, it was observed that the yellow rice stem borer population peaked during November and December, while the Malay stem borer population peaked in January and February.

Owing to the high stem borer population density during the dry season, the damage they inflict during the dry season is thought to be 8 times worse than during the rainy season.

In addition to Fenitrothion, depending on stem borer species and the variety of rice in cultivation, Gamma-BHC in pellet form has also been shown to be an effective chemical agent in combatting stem borers. In addition, studies to determine the death rate of yellow rice stem borers when field stubble is burned and the economy of chemical use are being pursued.

c) Other topics

Another big problem is crop damage caused by rats. This problem constitutes a major barrier to the introduction of dry season crops. With the dispatch of a technical staff member of the Tropical Agriculture Research Center, the rat species present and their ecology were studied while prevention countermeasures such as rat catching, poison bait and electrical fences were tested.

5) Agricultural machinery

a) The maintenance and repair of agricultural machinery

Large-sized cultivators, harvesting machinery, engines and motor vehicles are felt by the Cambodian staff to be indispensable tools and their utilization levels are very high. Unfortunately, however, equipment maintenance and management is not up to par and successive Japanese machinery managers have been hard pressed to keep equipment operational. Recently the problem has grown worse, since some machines are getting old and prone to breakdown. Although serviceable equipment and machinery are an important prerequisite for efficiently setting up experimental projects, it is very often the case that a piece of machinery has to be fixed before work can actually begin. (Please refer to the sections below on the state of machinery repair and the present state of the Center's machinery below.)

b) Testing on mechanized cultivation of wet rice

With the objective of reaping a large harvest for the 1965-66 dry season crop and confirming the viability of mechanized cultivation technology in Cambodia, tractors, bottom plow, disc harrow, tooth harrow, sower and swathe sprayer were employed. All three fertilizer types were applied in three lines between rows. Planting pointed up the need for human management. During harvesting, it was important to reduce the quantity of broken kernels (i.e., raise head yield) by reaping at the right time and employing optimal drying methods. In order to avoid plant collapse, shorter stemmed varieties need to be selected. Further consideration should also be given to the use of machinery during the entire planting and growth period.

c) After 1967 testing was conducted jointly with the Cultivation Department. At that time, relatively large quantities of fertilizer were used for cultivation. IR5 was planted during the rainy season and IR8 during the dry season. Whereas directly sown crops during the 1967 rainy season, 67-68 dry season and 68 rainy season produced yields of 6.0, 7.0 and 6.0 tons per hectare, respectively, transplanted seedlings during the same seasons produced yields of 7.0, 8.5 and 7.0 tons per hectare, respectively. In a mechanized high yield cultivation experiment employing IR5 which was conducted during the 1968 rainy season, yields were raised to 4.5 tons per hectare by random sowing, 4.8 t/ha by row sowing and 5.5 t/ha by seedling transplantation.

d) Engines

Although the diesel engines at the Center all exhibit considerable wear, the gasoline engines are like new. This is because the high cost of gasoline prevents them from being used. (Gasoline is 14 riels/l while first grade kerosene is 6 riels/l and second grade kerosene only 3 riels/l.) For subsequent equipment deliveries, diesel engines would be much preferred.

State of repair of principal farm machinery (September 1969 - May 1970)

Aside from everyday inspection and maintenance, the main repair work undertaken on important pieces of farm machinery and tools is listed below.

Bulldozer (D-80A Komatsu)
  Caterpillar adjustment (Cut off the track link, remove one sheet and adjust properly)
  Nozzle replacement
  Roller replacement
  Replace valve adjustment stem
  Valve fitting
  Dynamo repair
  Muffler repair
  Oil line repair

Bulldozer (Komatsu D-50 and backhoe)
  Roller replacement
  Spring replacement
  Brakeshoe replacement (on one side only)
  Nozzle adjustment
  Repair of backhoe arm (damage requiring welding of arm and pipe)
  Water pump
  Muffler

Combine (Massey Ferguson 39)
  Concave cylinder spiketooth bar adjustment
  (Because the two spiketooth bars were so difficult to adjust when the harvesting scythe was in operation, new parts were required.)
  Manufacture steel plate to reinforce upper and lower scraping auger
  Hydraulic pipe for platform needs to be replaced with a whole new unit

Generator engine (Yanmar 4ML)
  Nozzle valve adjustment
  Disassembly and cleaning of cylinder head
  Disassembly and cleaning of cooling system
  Fuel filter disassembly and cleaning
  Valve fitting

Truck
  Disassembly and adjustment of differential gear

Jeep
  Complete disassembly and cleaning followed by welding repair as a result of damage to chassis

Tractor
  Nozzle adjustment
  Dynamo repair
  Ring replacement
  Valve fitting

Cultivator/tiller
  Metal replacement
  Piston ring replacement
  Bearing replacement

* There was no list book for assembly of each section of the rice milling machine, a shortage of parts such as pulleys, and problems connected with the building in which it was housed. As a result we were unable to do a test run.

## The current state of repair of farm machinery (June 1970)

Bulldozers (2)

A Komatsu D-80A, D-50 and backhoe for the D-50 are in service. A nozzle on the D-80A (1 kit) urgently needs to be replaced. In addition, the oil seal O-rings in the hydraulic system also need replacement. The D-50 has been operated 5,000 hours longer than it should have and has lost power. It's time to think about an overhaul.

Tractors (6)

Five Komatsu WD-50s and one Kubota L-15 which are all in service. The WD-50s have been in service for over five years and have lost power. Considering the wear on this equipment, it's time to think about an overhaul.

Cultivator/tillers (7)
Iseki (1) Complete breakdown of cylinders, crankshaft with con-rod. No spare parts available
Kubota (2) Operable but engine spare parts needed
Kubota (1) Operable but engine spare parts needed
Yanmar (1) Operable but engine spare parts needed
Kubota (1) New unit
Kubota (1) Engine and chassis have broken down but reparable

Plows (8)
Bottom plow 18" x 1 Wing broken, parts needed
Bottom plow 14" x 2 Usable
Bottom plow 14" x 2 Usable
Disk plow 26" x 3 Bearing damage, parts needed. Hokuno, parts required
Disk plow Usable
Disk plow Usable
Disk plow 26" x 3 Bearing damage, disk damaged (broken)
Pull-type disk plow 30" x 5 (for bulldozer use) Usable

Drill seeder (3) Usable
High-cut plow, fertilizer applicator and sower
(1) Rotary and sowing assemblies damaged with no spare parts
Rotary (for tilling) (3) Usable
Spade harrow (for rotary harrowing) (1) Usable

Harrow
Offset harrow (1) For small tractors Usable
Tandem harrow (4) For large tractors Two have broken down

Spiketooth harrow (2) For large tractors Usable
Lime sower (for spreading fertilizer and lime) (1) Usable
Ridger (1) Usable
Ditcher (1) Usable
Broadcaster (2) Usable

Paddy wheel (for tractor use) (1 set)
Manufactured at the Agricultural Center Usable
Transplanter (Shibarau UK-13) (2) Usable
Cultivator (2)

Pumps
Vertical pump (11) Five of the units are new. All usable

Pump (Ebara) (4) Two units unusable due to lack of clasps. Two units usable. Only one of the units is usable as a suction pump, with the other three urgently in need of clasps.

Spraying and dusting equipment (5) All usable

Engines for general use (23)
  Diesel engine (6) Three broken units and no spare parts. Three units usable. Spare parts needed desperately
  Kerosene engine (3) All three units broken and no spare parts
  Gasoline engine (14) One unit broken and the 13 others are all new

* There are other gasoline engines at the Center but as they are considered irreparable, they have not been included in this description.

Mower (1) Usable

Trailers
  Dump trailer for use with large tractor (3)
    All usable, however due to a damaged hydraulic cylinder on one unit it is not usable for dumping

  Trailer for use with small tractor or cultivator/tiller (3)
    Two units usable. One trailer for use with a cultivator has no tires and is unusable. There are other trailers but they are considered irreparable and not listed here.

Harvesting equipment
  Rice harvester (2 units for reaping only) Usable
  Combine, Massey Ferguson 39 (1) Usable

Threshing equipment All usable
Belt conveyor (with attached engine) (1) Usable
Winnowner (3) Japanese-made Usable
Cutter (1) Usable
Pan raker (1) Usable

Generators and generator engines
  100kW/H (2 sets) In service
  Yanmar 4MI diesel engine Problem with engine seals; replacement parts needed desperately
  3kW/H (1) Usable

Water management equipment
  Pump (6) One unit is broken and two are brand new
  Chemical tank (2) Made of plastic and unusable. Urgently in need of replacement

Motor vehicles
  Truck (1) In service
  Microbus (1) In service
  Jeep (5) Three are broken
  Small truck (1) Unusable due to damaged gear case
  Passenger car (1) In use

Notes:

a) This list was put together as we were preparing to evacuate to Phnom Penh at the beginning of June, 1970.

b) Equipment breakdown and wear levels are very serious. Equipment considered irreparable has been eliminated from the count.

c) Equipment listed as 'usable' includes units which are in urgent need of replacement parts as a result of oil leaks and wear.

d) Tools tend to get scattered and lost. As a result, we end up tightening nuts with monkey wrenches.

## History of the Khmer-Japanese Friendship Agricultural Technical Center (unfinished manuscript) Feb. 25, 1970

| | |
|---|---|
| March 2, 1959 | Signing of the Khmer-Japanese Economic and Technical Cooperation Agreement. |
| July 6, 1959 | Agreement goes into effect. |
| Jan. 1960 | Agreement to send a preliminary survey team to Cambodia. |
| March 1960 | The Japanese Ministry of Agriculture and Forestry and Ministry of Health and Welfare dispatch 5 engineers to Cambodia (for a two month stay). |
| Oct. 1960 | Agreement on the provision and duties of Japanese engineers to be sent to Cambodia (period of stay: 17 - 21 months). |
| Oct. 1960 | Agreement on resources procurement (total value of 8.8 million yen). |
| Dec. 1960 | Nine engineers are dispatched to Cambodia. |
| March 1961 | Loading of supply ship completed. |
| April 1961 | One more engineer and technical staff dependents (five families) dispatched to Cambodia. |
| July-Oct. 1962 | Engineers return to Japan. First Agreement expires. |

With the dissolution of the Asia Society, its role assumed by OTCA (Overseas Technical Cooperation Agency)

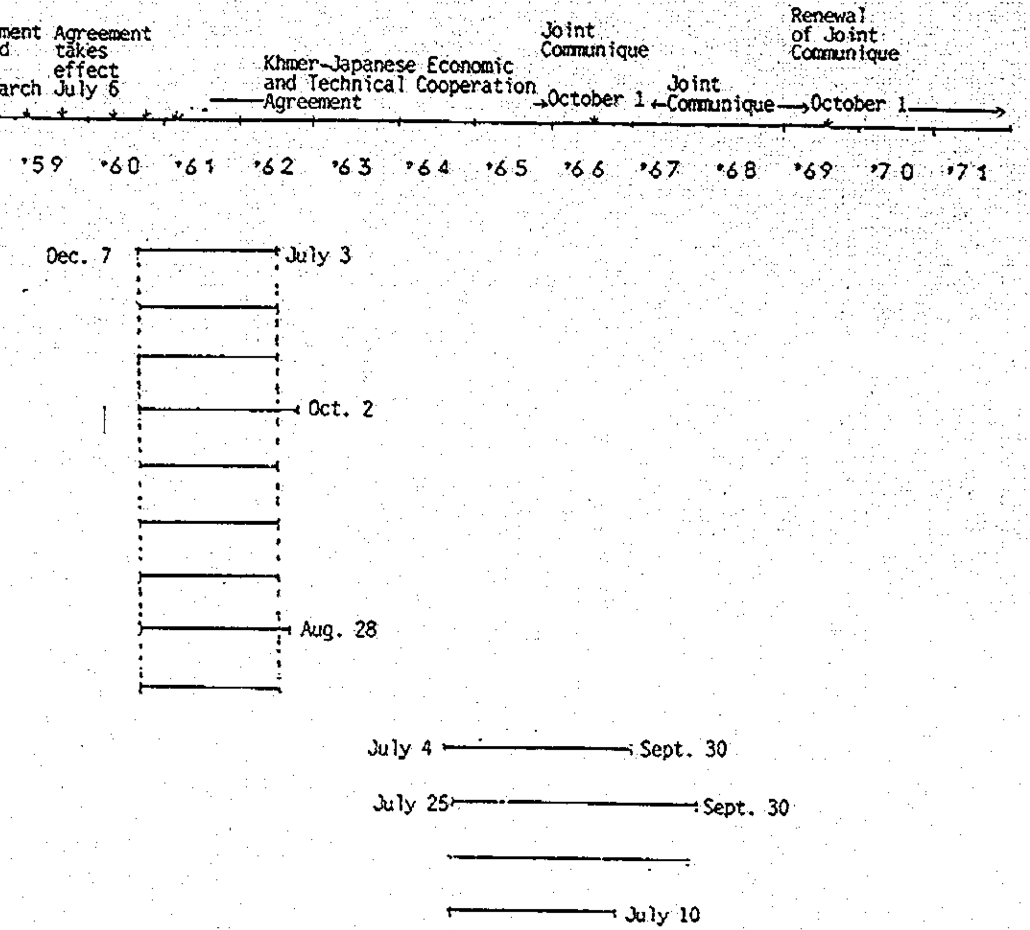
| | |
|---|---|
| April 1964 | Materials Procurement Agreement (for 60,270,000 yen) is concluded. |
| May 1964 | Agreement on the provision of Japanese technical staff to Cambodia and their duties (In that year seven engineers are dispatched in July, two in November and one in March 1965 for a total of 10.) |
| July 1964 | Center is established |
| July 1965 | Center Opening Ceremony |
| Sept. 1965 | The service period for Japanese technical staff expires pursuant to Economic and Technical Cooperation Agreement. The provision of Japanese technical staff continues, however, under the auspices of C.P. |
| June 1966 | A Japanese fact-finding delegation is dispatched to Cambodia to reformulate policy for the period following expiration of Agreement. (Three-year Field Preparation Plan is formulated) |
| Sept. 30, 1966 | "Joint Communique on operation of the Center established pursuant to the Khmer-Japanese Economic and Technical Cooperation Agreement" is signed. |

| | |
|---|---|
| October 1, 1966 | The stipulations in the Joint Communique take effect. |
| February 1969 | A Japanese fact-finding delegation is dispatched to Cambodia to reformulate policy for the period following expiration of the Joint Communique |
| Sept. 1969 | Joint Communique renewed. |

№1.

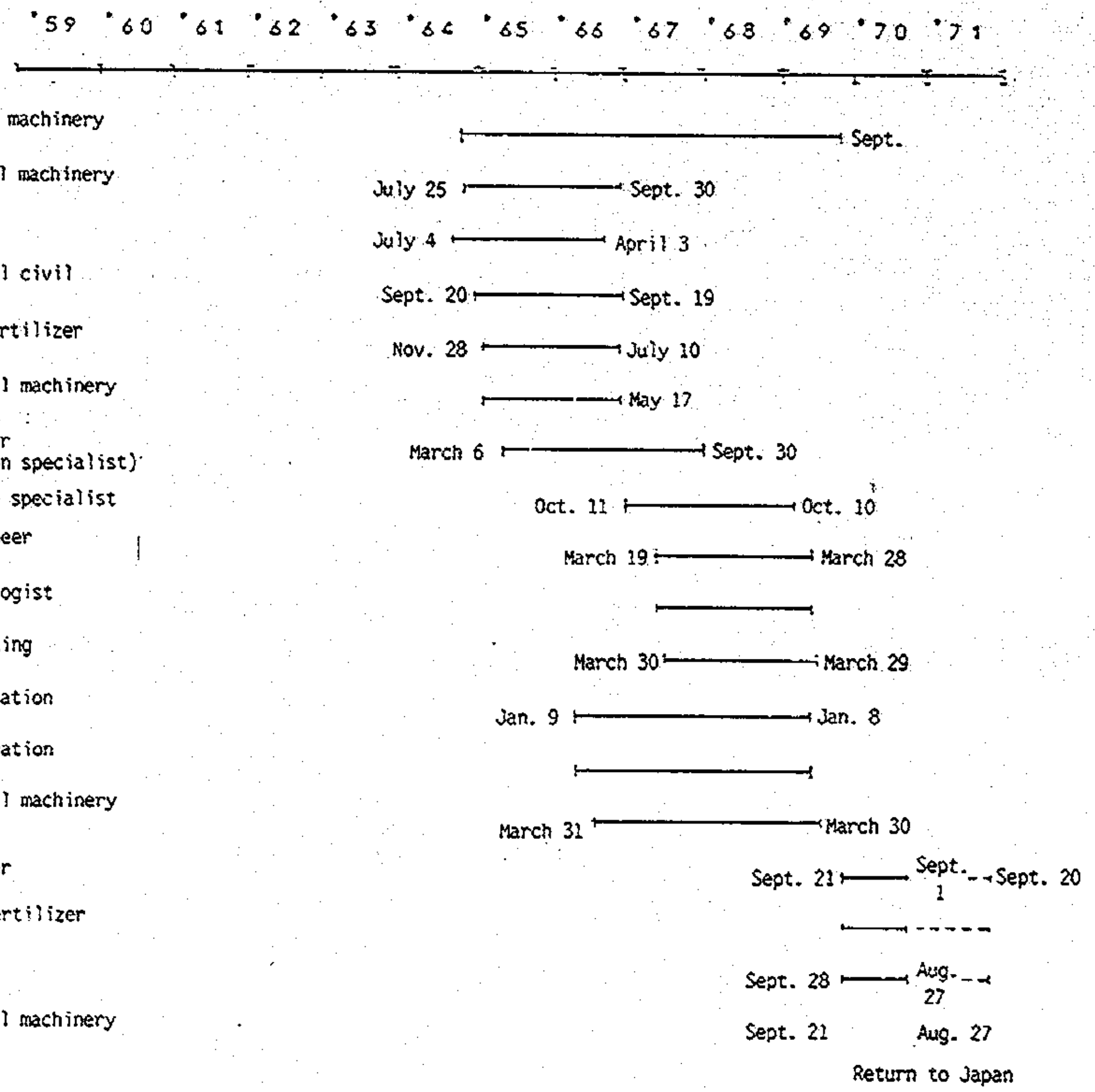
# Period of service for Japanese Technical Staff in Cambodia

The Khmer-Japanese Friendship Agricultural Center



| | | |
|---|---|---|
| Former Director of the Kanto Higashiyama Agricultural Test Center | Shiraishi Yokichi | Rice cultivation |
| Secretariat General Affairs Section | Goto Hiroshi | Agricultural economics |
| Koibuchi Gakuen | Sakai Hiroshi | |
| Hyogo University | Sato Takashi | |
| Kanto Higashiyama Agriculture Test Center | Yasuo Seigen | |
| Hokko Chemical Co., Ltd. | Hara Ichiro | |
| Nagano Management and Education Farm | Miyahara Kazuhiko | |
| Promotion Agency Research Department | Saburo Niizeki | |
| Secretariat General Affairs Section | Sakakibara Yonosuke | |
| Cooperation official | Yatta Sadao | Cultivation specialist |
| Cooperation official | Kimura Noboru | Harmful insects specialist |
| Cooperation official | Uchiyama Yasutaka | Cultivation specialist |
| Kyushu Agriculture Test Center | Sato Tetsuo | Phytopathologist |

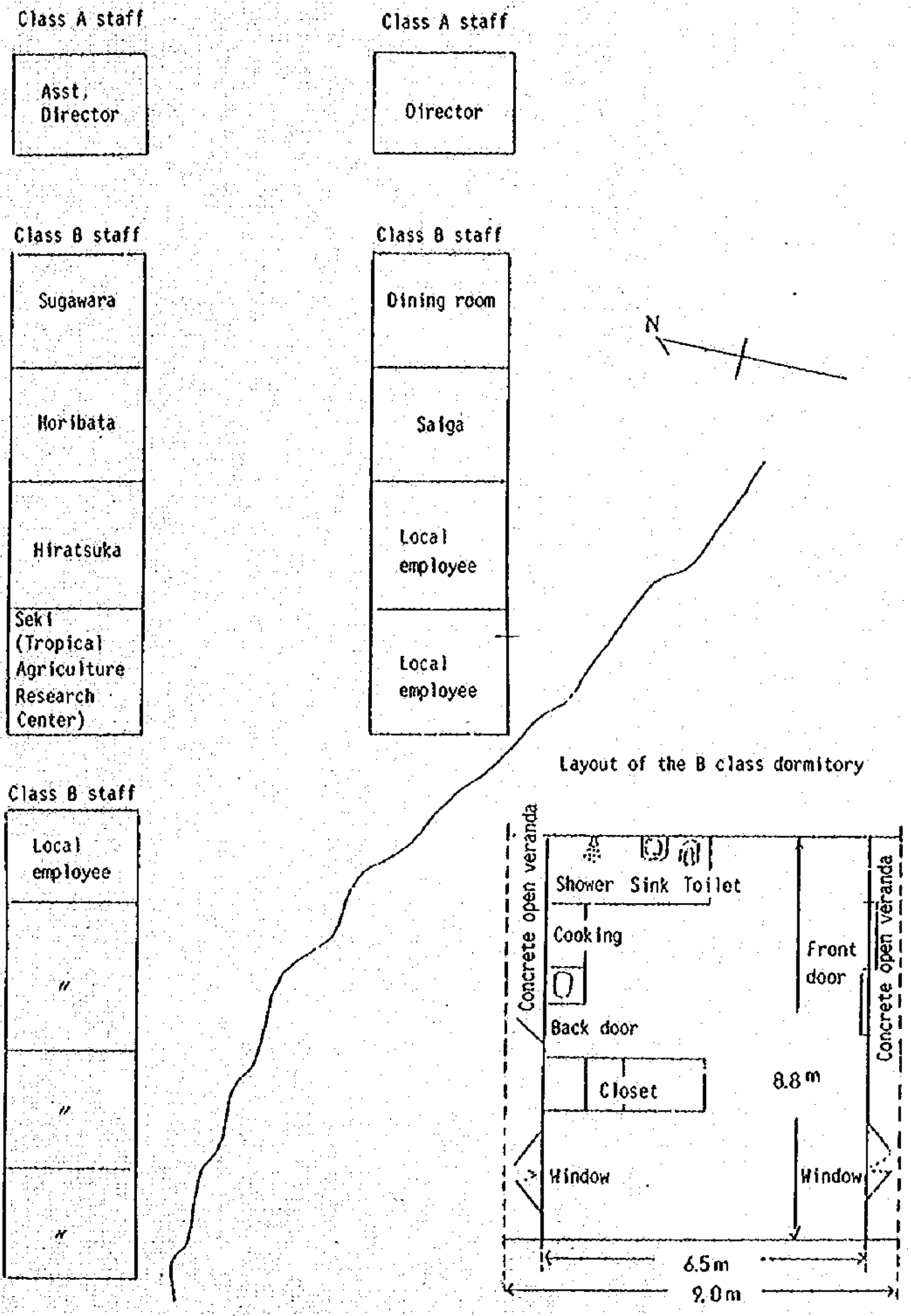
№2



| | | | | |
|---|---|---|---|---|
| Tokyo University of Agriculture and Technology | Tanabe Susumu | Agriculture machinery specialist | | Sept. |
| Hokkaido Agricultural Test Center | Akasaka Yasushi | Agricultural machinery specialist | July 25 | Sept. 30 |
| JICA | Yamamoto Yuzo | Interpreter | July 4 | April 3 |
| Farmland Development Machinery Group | Ujihara Hiroshi | Agricultural civil engineer | Sept. 20 | Sept. 19 |
| Engineer for Gifu Prefecture | Fukutomi Toshio | Soil and fertilizer specialist | Nov. 28 | July 10 |
| Yanmar Co., Ltd. | Yamazaki Seiichi | Agricultural machinery specialist | | May 17 |
| Technology Conference | Hirano Shun | Group Leader (Cultivation specialist) | March 6 | Sept. 30 |
| Secretariat Research Section | Shiraishi Masaji | Cultivation specialist | Oct. 11 | Oct. 10 |
| Farmland Development Machinery Group | Kobayashi Fumio | Civil engineer | March 19 | March 28 |
| Hokkaido Agricultural Test Center | Nemoto Masamichi | Phytopathologist | | |
| Agriculture and Technology Research Center | Sakaguchi Susumu | Plant breeding specialist | March 30 | March 29 |
| Cooperation team | Chiba Genji | Rice cultivation specialist | Jan. 9 | Jan. 8 |
| Cooperation team | Orihara Kunio | Rice cultivation specialist | | |
| Cooperation team | Kurosawa Kunihiro | Agricultural machinery specialist | March 31 | March 30 |
| Formerly of the Statistical Survey Dept. of the Ministry of Agriculture and Forestry | Saiga Chuzo | Group leader | Sept. 21 | Sept. 1 - - Sept. 20 |
| Engineer for Kanagawa Prefecture | Hiratsuka Toshio | Soil and fertilizer specialist | | |
| Chugoku Agricultural Test Center | Horibata Toshizo | Cultivation specialist | Sept. 28 | Aug. 27 - - |
| Former cooperation Team team | Sugawara Seikichi | Agricultural machinery specialist | Sept. 21 | Aug. 27<br>Return to Japan |

# Residential assignment and room occupation of Japanese technical staff

Feb. 25. 1970



## III. Problem points and opinions

### 1. Future direction of testing and research

The 1967 dry season crop at the Center utilized IR-8 to achieve a milled rice yield of 10 tons per hectare. This result showed that Cambodian agriculture with the proper management of rice variety and fertilization could achieve yields comparable to those in developed countries. However, when we look at the present state of Cambodian agriculture, the average farmer cannot meet the preconditions for duplicating this achievement. In fact, for some Cambodian farmers, the 10t/ha yield is nothing more than an indication of the limits of possibility. Then, there was the pursuit of higher yields by employing small amounts of fertilizer during cultivation. It had been shown that the addition of 30 - 60kg of nitrogenous fertilizer per hectare could double yields. Nevertheless, the country's farmers showed extremely little interest in technologies designed to increase yields. In spite of government appeals to employ fertilizer during cultivation, farmers have been singularly unresponsive. One reason for this is that they fear increased losses as a result of frequent natural disasters (droughts and floods) which human effort can do little at present to ameliorate. Another key reason, which would apply to many farmers who are willing to take risks, is the absence of financial resources. The means for investing in fertilizers simply aren't there. Of course, the improvement of irrigation facilities is being planned with assistance from the advanced countries. And, the Cambodian government in its efforts to boost agricultural production is promoting the development of small-scale irrigation facilities, but these efforts are progressing far too slowly.

The scale of farms managed by Cambodian farmers can be roughly divided into two categories which are also geographically meaningful. Large-scale agriculture takes place in Battambang Province and neighboring regions where there are also large expanses of abandoned fields. In other provinces of the country, the scale of agriculture is small. The Center is located in Battambang Province where the scale of agriculture is large and large tractors are heavily utilized. The fields at the Center itself are extremely large and lend themselves well to the conduct of mechanized cultivation experiments with large farm implements. However, acknowledging that small-scale, animal-powered rice cultivation is the rule in Cambodia and that the overwhelming majority of the farm population has little or no financial resources, our most urgent task should be to improve rice cultivation technology geared to an animal-powered agricultural system. Even if the results of technological improvement within such a framework are only modest, they are crucial as a first step on the road to bigger and better development in future.

Assuming this type of point of view, we will be obliged to revise our ideas on what direction and what course the development of rice cultivation technology in Cambodia should take? The present state of rice cultivation and the factors hampering improvement differ by region and the social stratum of farm families. Does this mean we have to establish a whole variety of rice culvation systems, and then attempt to insure, in the course of improvement research, that these systems advance and develop together? Or do some systems need to be given priority over others? In selecting themes for research, should each individual technology be viewed as part of a rice cultivation technology system? Should researchers collaborate and work be assigned with the objective of improving a particular targeted rice cultivation system?

As a result of the earnest efforts of senior technical staff, much has been achieved at the Center. Below, members of the technical staff have been asked to cite those research items which they feel should continue or be expanded. These items are listed according to the ordering and categories already employed earlier in this report.

Plant breeding

(1) Although work is underway to select the superior varieties from among the native rice species, it should be noted that selections are being made based on results from fertilizer-supplemented cultivation. Considering the small fraction of Cambodian agriculture in which fertilizer is actually applied, care should be taken not to omit varieites from consideration which perform well without fertilization.

(2) Rice varieties selected for cultivation during the dry season should be as resistant as possible to stem borers.

(3) With respect to promising varieties, adaptability testing to ascertain whether or not these varieties are usable in regions with different soils needs to be strengthened.

Cultivation

(1) Planting methods

A simple sowing machine for direct sowing compatible with animal-powered (and other forms of) agriculture needs to be developed in conjunction with the Machinery Department. Further testing is required on direct sowing during flood season.

(2) Culvation density

Although testing was conducted in the past, further study is required in which fertilization criteria and rice varieties are altered.

(3) Growth period (no. of days) in seedling bed

In testing that has taken place up to now, the planting date has been fixed and the number of days in the seedling bed varied. Under this testing regimen, the transplantation period varies -- a point whose significance needs to be investigated further. Consequently, in future testing, planting dates should be varied in such a way that the transplantation period for all the test subjects is the same.

(4) Weed eradication

The traditional method for weeding and thinning out the field in Cambodia is known as kopchou. Ongoing investigation into the basis for this technique is required. Weeding methods during the early growth phase of directly sowed rice require study and further testing is needed on shallow mid-term plowing and economical ways to use herbicide in dry fields.

(5) Research on the physiology and morphology of the rice plant

Employing native rice species in the unique tropical ecology of their country, Cambodian farmers have developed a rational system of rice cultivation based on centuries of accumulated experience. With this in mind, policies for the improvement of rice cultivation need to be firmly grounded in detailed study of the physiology and morphology of the native species.

(6) Other topics

In the implementation of rice cultivation testing, any kind of improved system of cultivation will have to give ample consideration to climate, soil, plant disease and harmful insects, and the use of machinery. In the process of test design, the joint collaboration of all research departments in the conduct of testing and experimentation is desirable as one aspect of the research.

Topics relating to future testing of soil and fertilizers

Although water may initially be a more crucial determining factor in improving Cambodian rice cultivation than soil, the soil and fertilizer categories also offer many possibilities for improvement. However, considering the social conditions of the farm population, its scant economic resources and farmers' lack of interest in improvement, the introduction of soil and fertilizer improvements at the present time would be highly problematic. In planning for the transition of technology from the testing stage to actual use, additional study needs to go into the issue of organizations that can popularize and educate the farming public, the selection of farmsteads to be used for demonstration purposes and the social environment required in order for the targeted technology to be accepted by the average farmer.

With these issues in mind, the following problem points have been raised with respect to the research on soil and fertilizer required in future.

(1) Cultivation methods, rice varieties and the prevention of plant disease and harmful insects predicated on cultivation with fertilizers all require thorough demonstrations.

(2) Thinking in larger terms, soil categorization corresponding to the soil composition and soil cross sections of the soils of Cambodia should be established. There should be a correspondence between the formation of comprehensive improvement policies and local geographical conditions.

(3) Although this report does touch on results obtained by means of supplemental fertilization of wet rice in its late growth phase, more research is needed into the effective utilization of fertilizers with minimal labor requirements.

(4) Problems with the application of organic fertilizer -- the customary burning of rice stubble; green manure from legumes and the rice straw which has not been reduced to compost; the securing of compost sources with due consideration to labor requirements and economy.

(5) A great deal of effort is going into the manufacture and development of domestically produced fertilizers -- especially phosphatic fertilizers.

Problem areas have to do with the development of fertilizer, testing for effectiveness and popularization.

(6) Bronzing, a problem occurring in rice cultivation throughout Southeast Asia (it is known as 'kra' in Cambodia) needs to be investigated from the angle of soil composition and fertilizers.

Topics relating to future testing of agricultural machinery

There absolutely needs to be better training with respect to the upkeep, maintenance and handling of farm machinery.

In the area of testing and research on the use of farm machinery, current work in the Center's producing fields has tended to focus mainly on large tractor tilling and combine reaping. We need to devise and develop new and improved farm tools specifically adapted to modes of cultivation in Cambodia.

In terms of the testing that should be conducted in future, the following is suggested:

(1) Testing to determine the operational efficiency of the combine with attention given to comparisons and differences between introduced rice varieties and native species.

(2) Investigate any correlations which might exist between machine cultivating/tilling and soil water content.

(3) Investigate impediments to the introduction of mechanized cultivation such as plant structure, soil composition, climate etc. and formulate countermeasures.

(4) Then formulate a rationalized system of mechanized operations.

(5) Explore improvements that could be implemented within the context of native agricultural methods, especially the animal-powered systems.

(6) The improvement and popularization of small farm tools and equipment, for instance, improved animal-drawn plows, trial production of a simple row sower, improved sorters, etc.

(7) What are the necessary preconditions which could usher in the use of farm machinery by Cambodian farmers? The use of large-scale farm machinery would entail joint use by an entire village. Research is needed to see whether or not this is socially and otherwise feasible.

## 2. The system of testing and research organizations in Cambodia

### 1) The nationwide system

There are a total of 10 agricultural testing stations in Cambodia. In comparison to these small testing stations, the Khmer-Japanese Friendship Agricultural Technical Center is an extremely large-scale and well-equipped agricultural testing facility. In spite of the many testing stations, it is unclear how they are operationally linked to each other. This organizational point needs to be clarified and a research system established in which the various stations have an organic relationship with each other. (Presently, a liasion project under government directive to test the application of fertilizers in wet rice cultivation is taking place at each station, but the analyses of results have been unsatisfactory.) Of course, when it comes to the organic relationship which should exist between stations, the extremely low level of technical competence (in comparison to the Agricultural Center) is also a problem. Nevertheless, the work of these small stations must be supported and advanced if any progress at all is to be made in future. Moreover, in advancing the work of these small test stations, the Agricultural Center may be able to aid them by disseminating technology.

Though the Center itself is located in an area of heavy, clayey soil, most of Cambodia's rice land is on sandy soil. Therefore, any breakthroughs or advances made at the center have to be tested for adaptability in other soils before they can be promoted to the farming public. Consequently, there is an urgent need for improved communications and cooperation between test centers to facilitate such progress.

2) The system in place at the Center itself

Although the assignment of research themes among the various departments at the Center should be organic and efficient, in the present situation, not much emphasis is being placed on this point. In terms of the way testing and research should be advanced at the present stage, a desirable cultivation system should be hypothesized and work assigned to each department according to areas of expertise. Depending on the theme, it may be advisable to conduct joint research.

3. Technical guidance

Cambodian technical staff members are strictly ranked as engineers, controllers or aide on the basis of educational background. This ranking system is highly rigid and neither years of service or meritorious achievement can change one's status. This system is probably one of the main causes for the low level of motivation vis-a-vis research displayed by Cambodian staff.

Providing technical guidance for the Cambodian staff is a time-consuming task requiring tremendous patience. When something needs to get done in a real hurry, the Japanese staff members often end up working by themselves. In the last analysis, dealing with the Cambodian staff comes down to either fostering their dependency or creating a human relations rift between Cambodian and Japanese staff. The unwilling, passive attitude on the part of Cambodian staff during the conduct of 1970 dry season crop testing and their complete reliance on the Japanese technical staff in putting together the 70-71 Testing Plan were nothing short of shocking.

The Cambodians' lack of independence and motivation may not be so much a function of low technical competence levels as an indication that they do not have a clear sense of the purpose for the testing and research that is going on. As far as they are concerned, once test results have been reported to the higher organization, their job is done. In the present absence of study groups, not to mention lack of specialized periodicals, there are virtually no opportunities for Cambodian staff to discuss or evaluate test results. Consequently, as far as the hard work they have expended goes, they do not develop a sense of achievement or a feeling that their work has been meaningful. At the present stage, where the thrust of research is on the development of usable technology, one would think that the sense of achievement would be very strong and directly felt in the process of spreading cultivation technology derived from testing and research at the Center to the average farmer. However, owing either to the lack of an organizational infrastructure for spreading farming technology or the existence of obstacles (we may not be aware of) to the spread of technology, there is no clear sense of achievement that they, the Cambodian staff, have been instrumental in bring valuable technology and know-how to the farming public.

On the basis of the foregoing discussion, the need for a more transparent, more concrete agricultural administration in Cambodia is apparent. And, although a clear grasp of the present state of agriculture and the level of awareness among farmers is crucial both to advancing research and motivating people to carry out research, there is at present very little discussion going on in this area.

An awareness of these points is also very important for Japanese technical staff assigned to give instruction. Technical skills alone may be enough to produce a technician of sorts, but not enough to produce an engineer capable of working independently and certainly not enough to imbue the Cambodian staff with the enthusiasm to acquire new technologies. The Japanese technical staff has to approach the discussion of questions like: What is needed first off to improve Cambodian rice cultivation? What technological systems capable of increasing production are transferable to farmers? How can the welfare of the farming population be promoted? from the administrative angle as well as from the viewpoint of the farmer. This discussion must involve the Cambodian staff. Moreover, it would be desirable if policy questions about the direction of research and testing themes could grow out of dialog. In doing so, the Cambodian staff would become aware of its ability to independently establish research themes and become more enthusiastic in the conduct of tests and the acquisition of technology.

None of this is going to be easy. The first major obstacle is language. The second is the inadequacy of the objective data on environmental conditions received to serve as the basis for dialog. The process of solving problems and making up for deficiencies is going to require a considerable amount of time.

The way things work now, Japanese technical staff is dispatched to Cambodia for a short period and then replaced by new personnel. A tremendous amount of time is required in repeated basic preparation. The overall result of this is not merely a tremendous waste of time, it also prevents anyone from going a step further than his predecessor. To enhance the effectiveness of instruction and the value of cooperation, Japanese technical staff should be assigned to duty in Cambodia for longer periods. In cases where extending the length of stay is not possible, the rotation method should be improved.

### 4. The need for Japanese technical staff with new tasks

It is only by closely integrating a whole series of undertakings that the desired effect, namely, improved rice cultivation, is going to be achieved. Such undertakings include the establishment of a systematic research plan with clear priorities, promotion of efficient testing and research pursuant to this plan, and the infrastructural preparation required to actively transfer techniques for improved rice cultivation to farmers (in some cases with government assistance).

At present, perhaps because of the low level of Cambodian technical competence, the Central Government has given reponsibility for the formulation of a research plan -- the starting point for work -- to the Center. As explained above, in actual terms this means that the formulation of the research plan is in the hands of the Japanese technical staff. So much for the close integration of a whole series of undertakings.

As far as the culture of data is concerned, Cambodia is an extremely backward country. It is next to impossible to gather data from remote regions. Since the Center itself is located in an outlying area, it is extremely rare for officials from Phnom Penh to visit. Staff from the Center is always expected to journey to Phnom Penh for meetings. Cambodian officialdom would do well to tour the country and get a feeling for actual conditions on the ground. Nevertheless, persons with tasks to perform locally are not, in our opinion, accorded any authority. Even if one expends the effort to visit organizations in the capital occasionally, communication is inadequate and such trips often turn into a waste of time. On this point, the Cambodian staff at the Center has shared the same experience.

What's essential in projects involving international cooperation is that your partner adequately understand what is going on, and going a step further, that he become actively motivated to participate in the process. Depending on the project, this may be even more important than the success or failure of results.

Considering these points together, in Cambodia today, close contact with the government is an indispensable condition for achieving success in the field of agricultural cooperation. In order to solve the problem points noted above, it would probably be beneficial to post at least one Japanese technical staff member in the capital.

The job responsibilities of that person would include:

(1) Collection and preparation of basic data required for the Research Plan (supplied to the Center).

(2) Participation in formulation of the Research Plan.

(3) Enlightenment of Cambodian government personnel with respect to research results.

(4) Maintenance of contacts with organizations responsible for the dissemination of research results.

(5) Gaging the effectiveness of technology and data dissemination and related problem points (supplied to the Center)

## 5. The fields

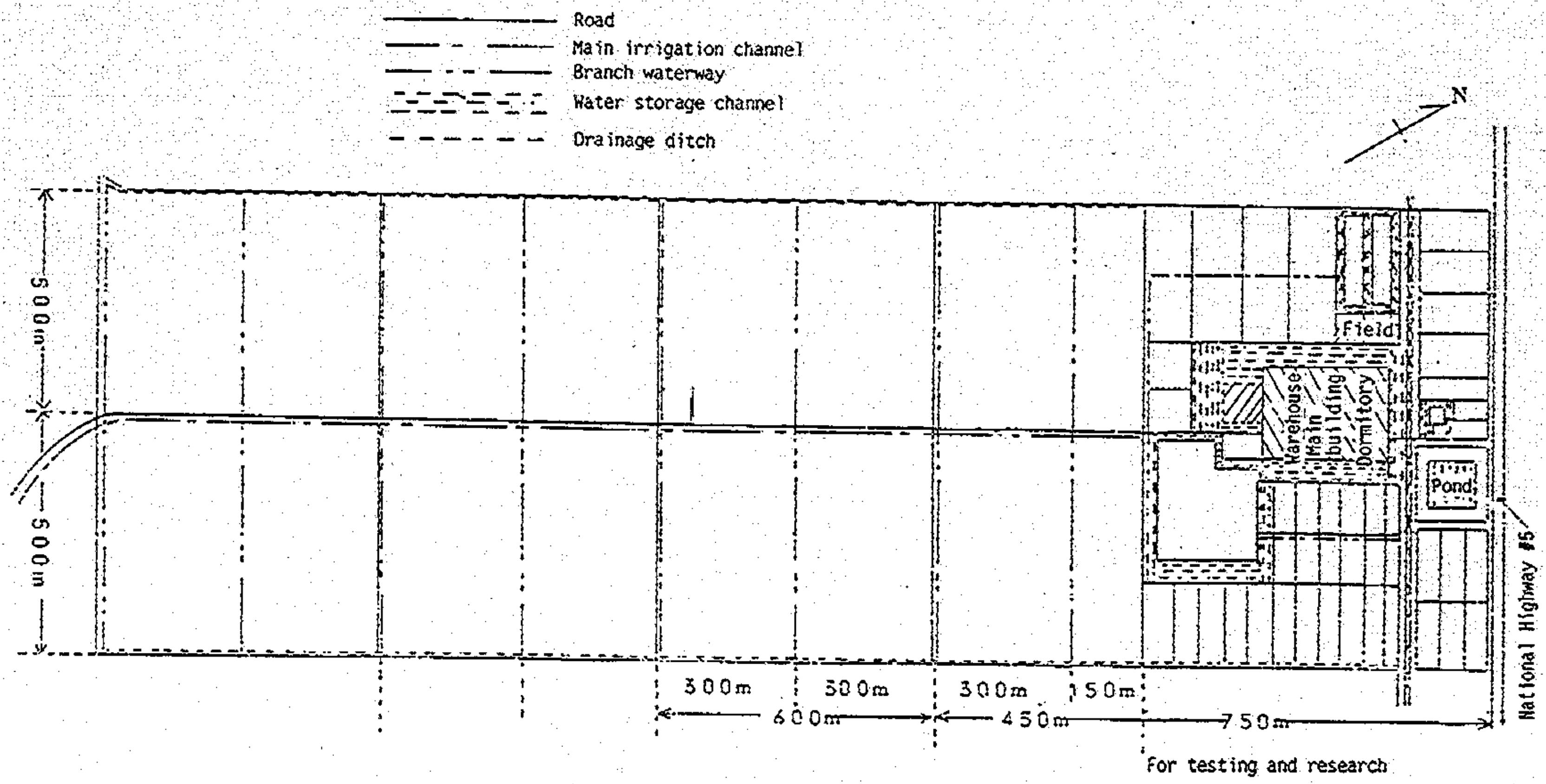
In terms of test fields, the 40 hectares (this parcel is close to the National Highway and is highlighted on Figure #4) which are now more or less ready for cultivation appear adequate for the Center's needs. Unfortunately, these 40 hectares are severely infested with rats. This may have something to do with the presence of the national railway line nearby which is thought to provide harborage for rats. Considering the importance of dry season crop testing in future, damage caused by rats could be the death knell for this effort. (Dry season test crops have failed during the last three years due to damage from rats.) If effective countermeasures against the rats cannot be found for this 40ha parcel, the test fields will have to be moved to another location which is as far from the railway line as possible.

The remaining 240 hectares of fields which comprise the Center are scheduled to be used for seed production. Seed cultivation will not be the direct responsibility of staff at the Center but will be subcontracted to local farmers. However, as explained above, field preparation is still not complete. Priority needs to be placed on completing field preparation. To achieve this, additional machinery will be required.

Each farm family subcontracted to raise seed will be responsible for one field and sixteen households will be employed. Each household will be responsible for a parcel of 15 hectares, so cultivation will be on a fairly large scale. In order to achieve this goal in a region where labor is in short supply, machine cultivation will be necessary. Considering that timely harvesting and proper drying to avoid broken kernels are required to insure the quality of the seed grain, the labor shortage will undoubtedly necessitate the use of a combine. In this situation, the question of how such large agricultural machinery is to be procured is a major concern. At least at the beginning, it will be difficult to expect the farmers to provide any capital. Aside from the issue of appropriate harvest timing, there is a fear among farmers that subcontracting farmwork and paying wages will pave the way for the intrusion of Overseas Chinese capital. Therefore, considering the present situation in Cambodia, initial procurement will most likely have to rely on Japanese aid. This brings to mind the proposal made by former Group Leader Hirano about setting up a Model Rice Cultivation Farm Exhibit. (The 1966 Annual Report of the Khmer-Japaanese Friendship Agricultural Center)

Figure #4

Blueprint of the Khmer-Japanese Friendship Agriculture Center



## 6. Housing for the Japanese technical staff

The Center is equipped with dormitories for the Japanese technical staff and local Cambodian employees. Since no one has to commute to work at the Center, it is very convenient. Nevertheless, there are certain problems deriving from the geographical location of the Center.

The first problem is the remoteness of the Center from neighboring villages which makes the purchase of daily provisions very inconvenient. This is also why cooking has to be communal. Although communal cooking is fine for single people, it can be problematic for families. Particularly where children are involved, problems can pile up and adversely impact the solidarity of the technical staff.

The lives of Center staff members and their dependents are completely tied to the Center. Residents do not have the option of simply leaving the Center and going to a nearby place for a change of air and atmosphere since there is nothing. This lack of diversion is undoubtedly one of the reasons that staff members become careless in their work. Since social contacts are limited to other residents of the Center and there is almost no opportunity to meet people from outside, it's very hard to acquire knowledge and get a feel for the area. Difficulties in finding a teacher to instruct the Japanese staff in the Khmer language have not made matters any easier.

Lack of electricity and plumbing are another big burden for the Japanese staff. Furthermore, when you put families from different walks of life with different incomes together in a tight-knit community like the Center there is bound to be some stress. To the Cambodian way of thinking, it is unnecessary to expend a lot of money in order to supply electricity and plumbing to a handful of Japanese. To do so would only detract from the solidarity between Cambodians and Japanese and this is undesirable.

Considering the residential situation at the Center as a whole, it would probably be advisable for the Japanese technical staff to reside in Battambang and commute every day to the Center. With the pavement now upgraded on the stretch of road between Battambang and the Center, this would mean a one way commute of some 30 - 40 minutes. Commuting would allow the staff to separate work from their private lives. With the recent apartment house construction going on in Battambang, it should be quite easy to secure appropriate residences for the Japanese technical staff and their dependents in the city.

# Part 2

## I. Test results from the 1969 rainy season crop

### Cultivation Department

Testing of the 1969 rainy season crop was based on the plan formulated by the previous Japanese technical staff and carried out by local Cambodian personnel. Since I was a newly-posted member of the technical staff, I did not personally get to see the condition of the fields when testing began, the execution of tests or the condition of seedlings. Nor did I have an opportunity to observe conditions during the initial growth period. I am therefore not in a position to provide accurate answers with respect to some test results and points of question. In this report, I will concentrate on reporting test data and limit speculation on the data obtained to relatively elementary topics. Owing to the political turmoil in Cambodia, our hurried departure, and the subsequent inadequacy of communications with the Center, preparing and organizing the data has been very difficult. Regrettably, some data was inadvertently left behind or forgotten at the center, a fact which explains why there are holes in the final report.

1. Testing to determine how planting density impacts wet rice growth and yield

This test was conducted in order to determine the optimal planting density for the rainy season wet rice crop in Cambodia and to provide data for improving rice cultivation in Cambodia.

1) Testing method

Tost field: A fertile field (alluvial lake soil) at the Center
Variety: Neang Menh Ton
Seeding transplantation: 30-day-old seedlings transplanted on June 27; three seedlings per clump
Fertilizers: 30kg per hectare each of N, P and K (mixed fertilizer in pellet form) were added to a manure base
Field division for the test: Each plot is 25 square meters with plots in pairs

Sample 1: 33.3 clumps/square meter (30cm x 10cm)
Sample 2: 26.6 clumps/square meter (25cm x 15cm)
Sample 3: 16.6 clumps/square meter (30cm x 20cm)
Sample 4: 11.1 clumps/square meter (30cm x 30cm)

2) Test results

(1) Growth process

Observed stem borer infestation was for the most part eradicated with the help of Gamma-BHC pellets. At around the time of earing, some plants were damaged by rats. These will not be considered in the study. The results of the growth survey are shown in Table #1 and Figures #1 and #2. In all the samples, tillering peaked on August 6, spikelet formation occurred on November 3, reaping began on January 13 and the growth period had a length of 232 days. Although plants seemed generally taller than those in randomly (less densely) planted plots, the variation in the test samples precludes any conclusions. The higher the planting density, the larger the number of stems and the higher the effective stem percentage in comparison to randomly (less densely) planted plots.

Figure #1: Plant height

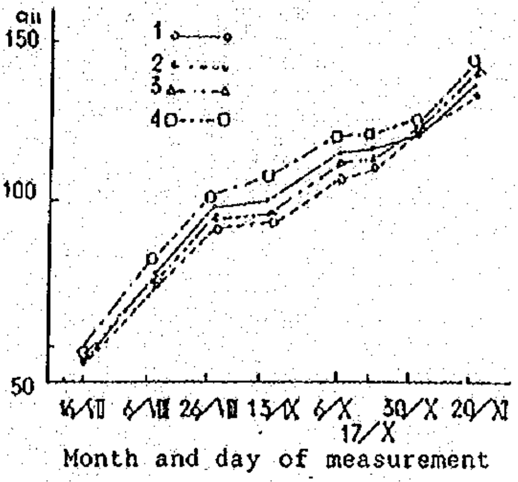


Figure #2: Number of stems

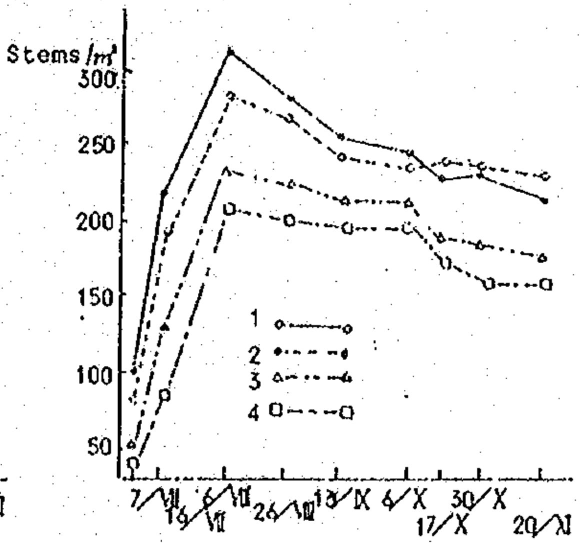


Table #1: Growth period survey

| Sample No. | Tillering peak | Spikelet formation | Earing | Reaping | Growth period |
|---|---|---|---|---|---|
| 1 | August 6th | November 3rd | November 30th | January 13th | 232 days |
| 2 | " | " | " | " | " |
| 3 | " | " | " | " | " |
| 4 | " | " | " | " | " |

(2) Yield constituent analysis

Survey results are as shown in Table #2.

Culm length, ear length: Longer in randomly (less densely) planted rice

Table #2: Yield constituent survey results

| Sample no. | Culm length | Ear length | No. of ears | Rough rice weight | Milled rice weight | Weight of imperfect rough rice | Total no. cary-opsides | Total no. of caryopsides developing to muturity | No. of imperfect cary-opsides | Weight of one ear of rough rice | No. of grains per ear | Milled rice weight ratio | Milled rice numeric ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | cm | cm |  | g | g | g |  |  |  | g |  | % | % |
| 1 | 126 | 22.0 | 213 | 528 | 462 | 66 | 25,582 | 22,511 | 3,071 | 2.16 | 122 | 88 | 88 |
| 2 | 127 | 21.7 | 225 | 584 | 520 | 64 | 25,593 | 24,196 | 1,397 | 2.31 | 108 | 89 | 95 |
| 3 | 134 | 22.7 | 182 | 559 | 491 | 68 | 25,670 | 23,460 | 2,210 | 2.70 | 141 | 88 | 91 |
| 4 | 138 | 22.8 | 155 | 521 | 460 | 61 | 24,141 | 22,131 | 2,010 | 2.97 | 156 | 88 | 92 |

Note: Twenty plants per plot examined (10 clumps per plot).

Number of ears: The largest number of ears were observed in the plots planted with 26.6 clumps per square meter. A planting density lower or higher than this results in a lower number of ears. In other words, in densely planted plots where luxuriant plant growth was observed, the effective stem percentage was lower. Due to the lower number of stems in the randomly (less densely) planted plots, an adequate number of ears could not be secured.

Total number of caryopsides: In the randomly (less densely) planted plots with a density of 11.1 clumps per square meter (Sample No. 4), the low number of ears means, of course, that the total number of caryopsides is likewise low. At around 25,600, the total number of caryopsides did not vary much between Samples No. 1, 2 and 3.

Number of milled rice grains: The plots with a planted density of 26.6 clumps per square meter displayed the highest numbers and the milled rice numeric ratio was also high. The plots with a planted density of 16.6 clumps also displayed a high number of milled rice grains, while plots with higher and lower plant densities displayed somewhat lower yields.

Number of grains per ear:
The number of grains was generally higher than in randomly (less densely) planted plots.

1000-grain weight:
Almost no variation was observed among the various samples.

(3) Yield survey results

Survey results are shown in Table #3.

Table #3 Yield survey results

| Sample no. | Total weight | Straw weight | No. of ears | Max. no. of stems | Effective stem percentage | Rough rice weight | Milled rice weight | Weight of imperfect rough rice | Per ear rough rice weight | 1000-grain weight of rough rice | Milled rice to straw weight ratio | Milled rice weight percent. | per hectare uield |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | g | g |  |  | % | g | g | g | g | g | % | % | ton |
| 1 | 2,033 | 1,134 | 214 | 315 | 68 | 541 | 482 | 59 | 2.3 | 22.5 | 43 | 89 | 4.82 |
| 2 | 2,188 | 1,146 | 223 | 282 | 79 | 606 | 558 | 48 | 2.5 | 22.0 | 49 | 92 | 3.58 |
| 3 | 1,964 | 1,078 | 190 | 237 | 80 | 551 | 515 | 36 | 2.7 | 22.5 | 48 | 93 | 5.16 |
| 4 | 1,900 | 1,081 | 161 | 210 | 77 | 495 | 447 | 48 | 2.8 | 22.0 | 41 | 90 | 4.47 |

Note: Six square meters (2-square meter patches from three different places) of a plot were reaped and an average taken for two plots.

Total weight:
Higher than in the densely planted plots.

Total rough rice weight:
The plots with a planted density of 26.6 clumps per square meter exhibited the highest rough rice weight, followed by plots with 16.6 clumps per square meter. Plots with higher and lower plant densities had somewhat lower weights.

Milled rice weight:
Highest in the plots with a planted density of 26.6 clumps per square meter, and progressively lower in the plots with 16.6, 33.3 and 11.1 clumps per square meter. Weight trends were the same as those observed for total rough rice weight.

Weight of one ear of grain:
Higher than in randomly (less densely) planted plots.

1000-grain weight:
Almost no variation between the test samples.

Yield:
At 5.58 t/ha, the plots with a planted density of 26.6 clumps per square meter had the highest yields. These were followed by those planted with 16.6 clumps per square meter which yielded 5.15 t/ha, 33.3 clumps per square meter which yielded 4.82 t/ha and 11.1 clumps per square meter which yielded 4.47 t/ha. The high yield of the 26.6 clump plots is explained by their high number of ears, high total rough rice weight and high milled rice weight ratio. The high density plots exhibited lower milled rice to straw weight ratio and lower milled rice weight ratio, while the randomly (less densely) planted plots had an insufficient number of ears. As a result, yields in both the higher and lower density plots were somewhat lower.

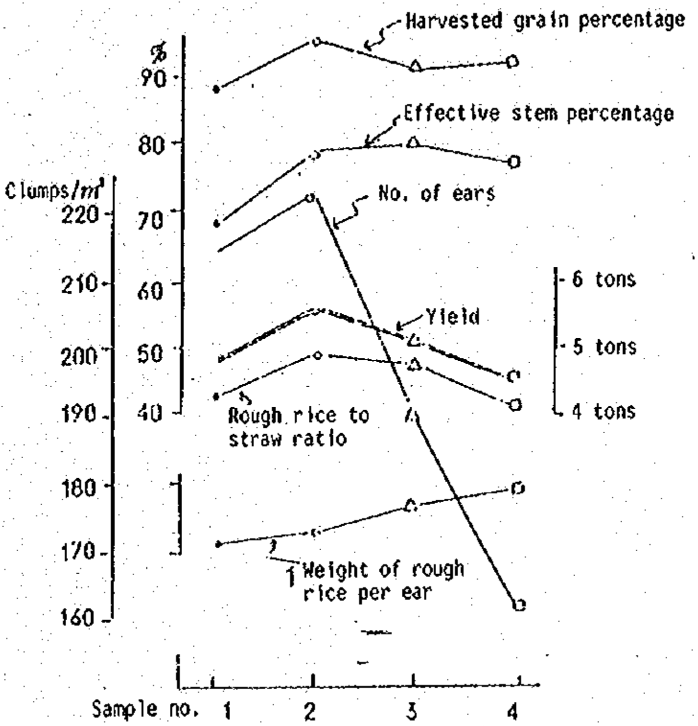
3) Summary

(1) Within the scope of this test, it was ascertained that a planting density of 16.6 - 26.6 clumps per square meter was optimal.
(2) In the high density plantings (33.3 clumps per square meter), in spite of luxuriant foliage, the effective stem percentage was lower and grain

weight per ear lower.

(3) In the randomly (less densely) planted (11.1 clumps per square meter) plots, although the number of grains per ear was high, the number of stems was insufficient, resulting in a low number of ears and reduced yield.

Figure #3 Yield and plant characteristics



2. Testing to determine how the quantity of fertilizer impacts wet rice growth and yield

This test was designed to establish what impact fertilizer quantity has on the growth and yield of the rainy season wet rice crop, to clarify the details of this process and to provide data for improving rice cultivation in Cambodia.

1) Testing method

Test field: A fertile field (alluvial lake soil) at the Center
Variety: Neang Menh Ton
Seedling transplantation: Performed on June 26
Planting density: 26.6 clumps per square meter (25cm x 15cm); three seedlings per clump
Field division for the test: 25 square meter plots in pairs

| Sample no. | Total quantity of fertilzier N.P.K. | Base (first application) N.P.K. | Supplemental applications | | |
|---|---|---|---|---|---|
| | | | 20 days after transplantation N.P.K. | 10 days before spikelet formation N.P.K. | At earing N.P.K. |
| 1 | 0 | 0 | 0 | 0 | 0 |
| 2 | 30-30-30 | 30-30-30 | 0 | 0 | 0 |
| 3 | 30-30-30 | 0 | 0 | 30-30-30 | 0 |
| 4 | 60-60-60 | 30-30-30 | 0 | 30-30-30 | 0 |
| 5 | 90-90-90 | 30-30-30 | 30-30-30 | 30-30-30 | 30-30-30 |

Note: Mixed fertilizer was applied in pellet form (15-15-15).

2) Test results

At this point the reader should be informed that, owing to our hasty evacuation which took place while we were in the midst of exchanging data with our Cambodian counterparts, we only managed to take some notes with us, while the primary data remained in Cambodia. It's unfortunate that this report cannot be based on the official record of results. Consequently, the following discussion will be based on what we could conclude from the partial data we were able to carry out.

(1) Growth period

The damage sustained as a result of stem borer and rat infestation is the same as that noted in the preceding test.

Tillering peaked in all plots on August 5 and no variations were observed in the timing of earing, maturation or the number of growth days to maturation.

Number of stems:
High numbers were observed in the heavily fertilized plots (Sample nos. 4 and 5) and those plots which received a base application (Sample nos. 2, 4 and 5).

Effective stem percentage:
Plots which received an application of fertilizer ten days prior to spikelet formation (Sample no. 3) exhibited the highest percentage: 74%. The unfertilized plot (Sample no. 1) was in second place with 69% while all the other plots were somewhat lower.

(2) Yield constituent survey results

In the plots which received large quantities of fertilizer, plants were superior in terms culm length, ear length and number of ears, but the milled rice weight ratio was lower.

In comparing the plot which received a base fertilizer application (Sample no. 2) to the plot which received a fertilizer application ten days prior to spikelet formation, Sample no. 2 exhibited a higher straw weight than Sample no. 3, a lower milled rice to straw weight ratio and lower 1000-grain weight.

(3) Yield survey results

Heavily fertilized plots (Sample no. 5): Although total weight, straw weight and number of ears were all high, the milled rice to straw weight ratio was amazingly low. Furthermore, with a low number of grains per ear, yield was not as high as that for Sample no. 3. Yield was, however, superior to Sample nos. 1 and 2.

| | |
|---|---|
| Sample no. 3: | Exhibiting a high milled rice weight ratio, ear weight and 1000-grain weight, this Sample had the highest yield: 5.57 t/ha. |
| Sample no. 4: | The results for this Sample were similar to those of Sample no. 5. Yield, however, was somewhat lower than Sample no. 5. |
| Sample no. 2: | Low ear weight spelled a low yield for this Sample. |
| Sample no. 1: | Owing to unfertilized cultivation, these plots had an insufficient number of ears and, therefore, low yield. |

3) Summary

(1) Within the scope of this test, the following was learned about methods of fertilizer application for local varieties: Fertilizer application ten days prior to spikelet formation (Sample no. 3) is effective, moreover 30kg/ha for all three fertilizer types (N, P, K) was adequate.

(2) How did plots which received a 30kg/ha base application fare? Comparison of plots with and without (Sample no. 3) base applications reveals no difference in total weight. However, plots which received a base application exhibit higher straw weight, lower milled rice weight and inferior marks for effective stem percentage and grain weight per ear.

(3) In heavily fertilized plots, total weight, straw weight and number of ears were high, but the milled rice to straw weight ratio was amazingly low. The number of grains per ear was also low. Consequently, it can be concluded that quantities of fertilizer in excess of 30kg/ha (for each type) did not increase yields in the test fields at the Center.

3. Testing to determine the optimal number of seedlings per transplanted clump

The purpose of this test is to find out if varying the number of seedlings per transplanted clump will impact the growth and/or yield of wet rice grown in Cambodia and to provide data for improving wet rice cultivation techniques in that country.

1) Testing method

Test fields: Paddy with alluvial lake soil
Variety: Neang Menh Ton
Transplantation date: Thirty-day-old seedlings were transplanted on June 28.

Plant density: 26.6 clumps per square meter
Fertilization: 60kg/ha each of N, P and K, half of which was in the form of a supplemental application
Field division for the test: 25 square meter plots in pairs

| Sample no. | No. of seedlings per clump |
|---|---|
| 1 | 2 seedlings |
| 2 | 4 seedlings |
| 3 | 6 seedlings |

2) Test results

(1) Growth period

The damage sustained as a result of stem borer and rat infestation is the same as that noted in the preceding tests.

No variation in growth period was observed among the samples. Tillering peaked on August 6, spikelet formation occurred on November 3, reaping on January 14, and the plants in all plots had a growth period of 233 days.

No variation in plant height was observed among the samples.

It was observed that the higher the number of seedlings per clump, the higher the number of stems. The effective stem percentage was highest in plots with 4 seedlings per clump. The number of ears was highest in plots where the number of stems were high, namely in plots with 6 seedlings per clump, while number of ears was rather low in plots with 2 seedlings per clump.

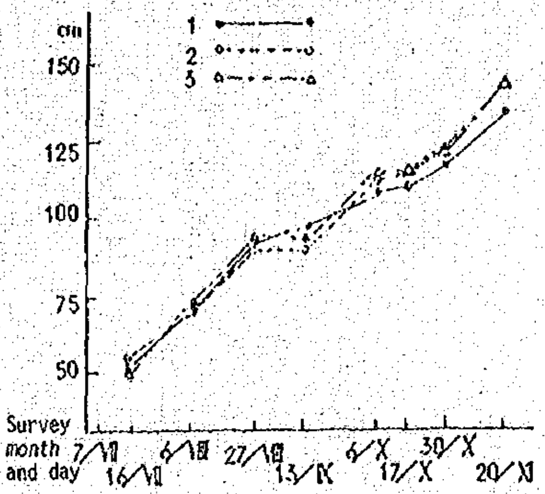


Figure #4: Plant height

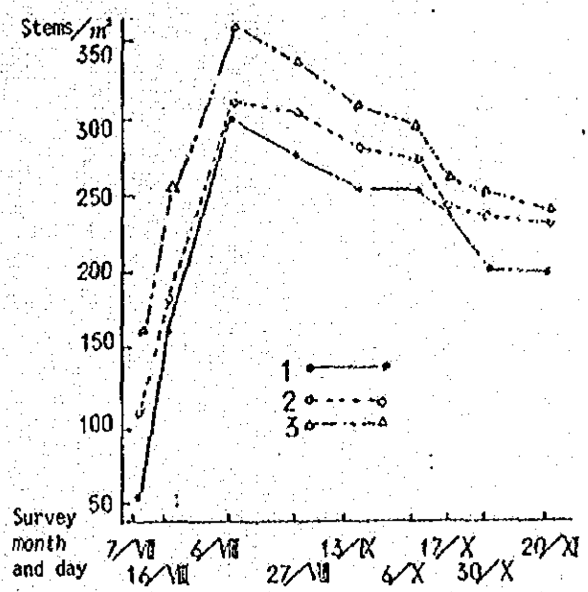


Figure #5: Number of stems

3) Yield survey results

Table #4: Yield survey results

| No. of seedlings per clump | Total weight | Straw weight | No. of ears | Max. no. of stems | Effective stem percentage | Total rough rice weight | Milled rice weight | Weight of unharvested grains | Rough rice weight for one ear | 1000-grain weight | Rough rice to straw ratio | Milled rice ratop | Yield per hectare |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 1,714 g | 1,035 g | 205 | 303 | 68 % | 545 g | 531 g | 14 g | 2.7 g | 22.0 g | 51 % | 97 % | ton 5.31 |
| 4 | 1,737 | 1,021 | 231 | 310 | 75 | 575 | 565 | 10 | 2.4 | 22.5 | 55 | 98 | 5.65 |
| 6 | 1,952 | 1,155 | 235 | 349 | 67 | 576 | 560 | 16 | 2.4 | 22.3 | 48 | 97 | 5.60 |

Note: 6 square meters of a plot (2-square meter patches from three places) were reaped and then an average taken based on two of such samplings.

Plots planted with 2 seedlings per clump:
Rough rice weight per ear is high, but owing to the insufficient number of ears the yield was 5.31 t/ha, the lowest among all the Samples.

Plots planted with 4 seedlings per clump:
Although the number of ears in these plots was lower than that for plots with 6 seedlings per clump, thanks to the high milled rice ratio and 1000-grain weight, these plots had the highest yields: 5.65 t/ha. Moreover, the rough rice to straw ratio was high and, in comparison to the other Samples, growth was more robust.

Plots planted with 6 seedlings per clump:
Although total weight, straw weight, number of stems and number of ears were all high, the milled rice ratio and 1000-grain weight for this

Sample were lower than plots planted with 4 seedlings per clump. Yield was 5.6 t/ha. These plots also had the lowest rough rice to straw ratio among the test Samples.

4) Yield constituent survey results

Table #5: Yield constituent survey results

| No. of seedl-ings per clump | Culm length | Ear length | No. of ears | Total rough rice weight | Milled rice weight age | Un-harvested rough rice weight | Total no. of cary-opsides | No. of cary-opsides harvested as grain | Un-har-vested cary-opsides | No. of grains per-ear | Har-vested grain per-centage | Miled rice weight per-centage | Grain weight per ear |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 129 cm | 22.4 cm | 215 stems | 572 g | 548 g | 24 g | 26,424 | 24,396 | 2,042 | 123 | 92 % | 96 % | 2.55 g |
| 4 | 131 | 21.9 | 231 | 582 | 560 | 22 | 25,799 | 23,112 | 2,687 | 111 | 90 | 96 | 2.42 |
| 6 | 130 | 21.7 | 230 | 278 | 554 | 24 | 25,808 | 23,016 | 2,792 | 100 | 88 | 97 | 2.41 |

Note: An average of 20 clumps per plot were sampled and separated for ripeness on the basis of a 1.06 Baumee hydrometer reading.

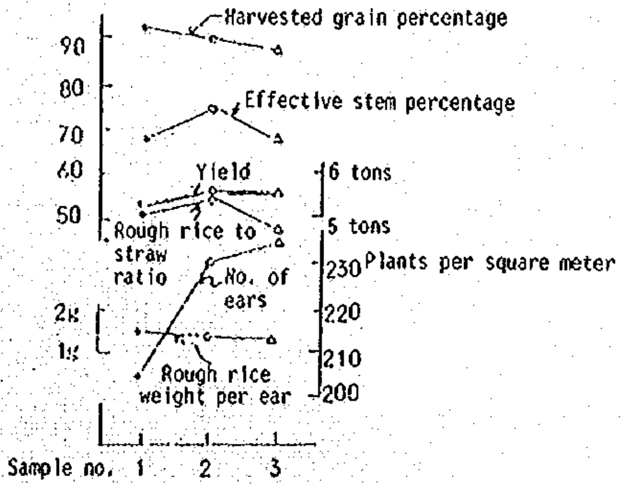
Culm length, ear length: Almost no variation was observed among the Samples.

Number of ears:
Although there was no difference between clumps with 4 or 6 seedlings each, clumps with 2 seedlings had a considerably lower number of ears.

Harvested grain percentage, number of grains per ear and the grain weight per ear: Statistics in these categories were higher for clumps with few seedlings.

Total rough rice weight, milled rice weight: Statistics in this category were highest for clumps with 4 seedlings, followed by those with 6 and then 2 seedlings. Almost no variations in milled rice weight percentage were observed among the Samples.

Figure #6: Yield and plant characteristics



5) Observations

Testing in this instance was conducted using native species and large quantities of fertilizer. According to the test results obtained, clumps with only 2 seedlings (Sample no. 1) were unable to develop a sufficient number of stems which meant a smaller number of ears and reduced yield. Although the absolute number of stems in clumps with 6 seedlings (Sample no. 3) was high, the effective percentage was in fact low. Considering the number of stems, the number of ears was low. Six seedling clumps exhibited somewhat more luxuriant leaf growth than the other samples which explains the lower rough rice to straw ratio. Grain weight per ear and harvested grain percentage were likewise low and, considering the number of ears, the yield was low. Although the plot with four seedlings per clump (Sample no. 2) had a smaller number of stems as compared with Sample no. 3, thanks to a high effective stem percentage, the number of ears for these two Samples were roughly equivalent. In terms of yield, Sample no. 2 displayed superior (per ear) rough rice weight and harvested grain percentage as compared to Sample no. 3. It's yields were the highest among the Samples tested.

Based on the above results, at the control fertilizer levels employed in these tests and a planting density of 26.6 clumps per square meter, it was shown that around four seedlings per transplanted clump were the optimal number.

4. Testing to determine how seedling age (no. of days in the seedling bed) impacts wet rice growth and yields?

The cultivation of wet rice in Cambodia is completely dependent on natural rainfall. Consequently, even if seedling bed preparation starts early, transplantation must wait until the rains come. When the rains are late, as they often are, delayed transplantation means that the number of days the seedling spends in the seedbed is greater than anticipated. In Cambodia, depending on the year and the exact location, it is not at all unusual for the seedlings to be left for a rather long period in the seedbed prior to transplantation. This test is designed to determine how the length of the growth period (number of days) in the seedbed impacts subsequent wet rice growth and yield, thereby providing additional data on how wet rice cultivation and technology might be improved in Cambodia.

1) Testing method

Test field: Fields with alluvial lake soil at the Center
Variety: Neang Menh Ton
Planting period: May 27
Transplantation period: June 21 - July 21
Planting density: 26.6 clumps per square meter (25 cm x 15cm); each clump with three seedlings
Quantity of fertilizers: 60 kg/ha each of nitrogen and phosphates (half of which was employed as a base application)
Field division for the test: 25 square meter plots in pairs

| Sample no. | No. of days in seedbed | Transplantation date |
|---|---|---|
| 1 | 25 days | June 21st |
| 2 | 35 days | July 1st |
| 3 | 45 days | July 10th |
| 4 | 55 days | July 21st |

2) Growth conditions

The damage sustained as a result of stem borer and rat infestation is the same as that noted in the preceding tests.

In terms of rice plant growth in Samples with varying transplantation dates, early growth tends to be more robust in those plots which were transplanted early. However, after October 6 or thereabouts, variation between Samples diminishes.

Figure #7: Plant height

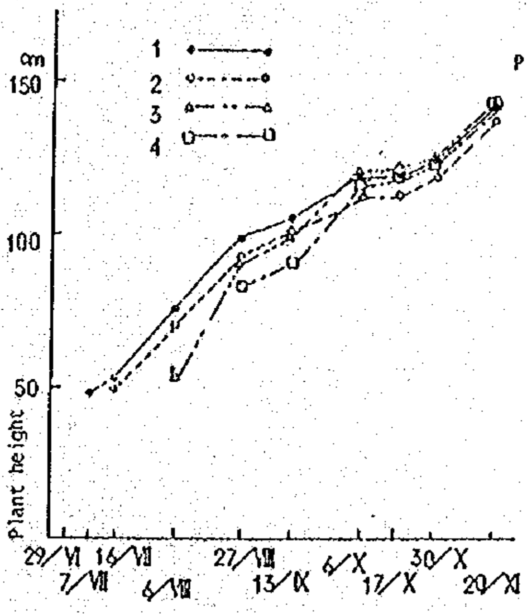
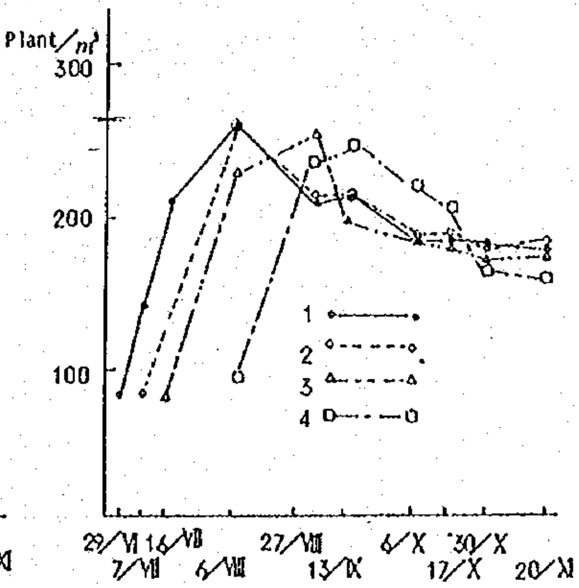


Figure #8: Number of stems



No differences were noted in the growth period of the various Samples; spikelet formation occurred around November 15, earing on December 10 and reaping on January 15.

Although early transplantation is thought to have an impact on the number of stems to develop, young seedlings 25- and 35-days-old developed a larger number of stems while 45- and 55-day old seedlings developed fewer. The peak of tillering occurred around August 6 in the 25- and 35-day-old seedlings, while tillering peaked later, on August 27 for the 45-day-old and on September 13 for the 55-day-old seedlings.

Plots with younger seedlings tended to have a larger number of ears, although no significant differences were note with respect to effective stem percentage.

### 3) Yield survey results

Young seedlings displayed superior total weight, straw weight and number of ears. No differences were discernible among the Samples with respect to ear weight, rough rice to straw ratio or 1000-grain weight. Differences in yield between the Samples are attributable to differences in number of ears. Although yields from young seedlings tended to be higher, except for the plots with 55-day-old seedlings, these differences were quite small.

Table #6: Yield survey results

| Seedling age (no. of days) | Total weight | Straw weight | No. of ears | Max. number of stems | Effective stem percentage | Total rough rice Weight | Milled rice weight | Weight of un-harvested grains | Ear weight | Rough rice to straw ratio | 1000-grain weight | Yield |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| days | g | g | | | % | g | g | g | g | % | g | ton |
| 25 | 1,679 | 921 | 180 | 258 | 70 | 496 | 487 | 9 | 2.8 | 54 | 23 | 4.90 |
| 35 | 1,360 | 937 | 178 | 258 | 69 | 487 | 475 | 12 | 2.7 | 52 | 23 | 4.87 |
| 45 | 1,366 | 881 | 172 | 251 | 69 | 471 | 458 | 13 | 2.7 | 53 | 23 | 4.71 |
| 55 | 1,322 | 824 | 164 | 243 | 68 | 463 | 450 | 13 | 2.7 | 56 | 23 | 4.63 |

### 4) Yield constituent analysis

Table #7: Yield constituent survey results

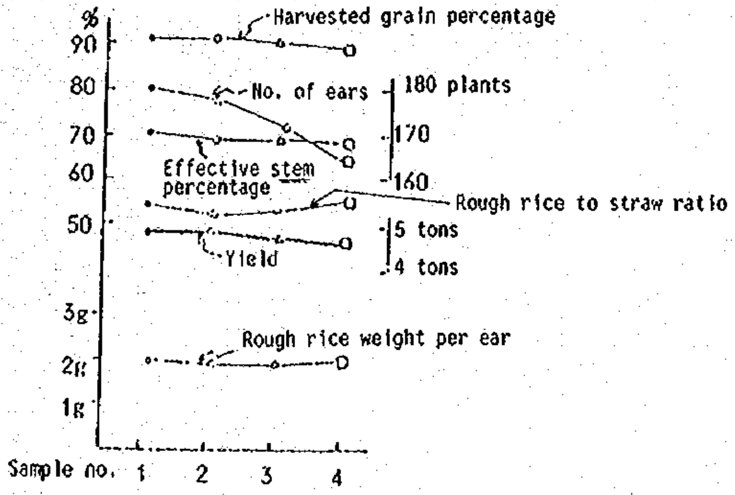
| Seedling age (no. of days) | Culm length | Ear length | No. of ears | Total rough rice weight | Milled rice weight | Un-harvested grain Weight | Total no. of cary-opsides | No. of har-vested grains | No. of unhar-vested grains | Ear weight | No. of grains per ear | Harvested grain percentage |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| days | cm | cm | | g | g | g | | | | | | % |
| 25 | 134 | 22.4 | 179 | 517 | 447 | 70 | 23,019 | 20,990 | 2,029 | 2.00 | 94 | 91 |
| 35 | 129 | 21.4 | 180 | 515 | 447 | 68 | 23,166 | 21,094 | 2,072 | 1.98 | 94 | 91 |
| 45 | 137 | 21.6 | 175 | 502 | 434 | 68 | 23,647 | 21,328 | 2,319 | 1.98 | 98 | 90 |
| 55 | 126 | 21.9 | 166 | 488 | 435 | 53 | 22,067 | 19,642 | 2,425 | 2.10 | 95 | 89 |

Looking at the results of the yield constituent survey, although the 55-day-old seedlings had somewhat shorter culm length and harvested grain percentages were lower, differences with the other Samples are not discernible.

5) Observations

Where seedlings of different ages were employed in wet rice cultivation, the 55-day-old seedlings, owing to aging and late transplantation, had a lower number of ears, a somewhat lower harvested grain percentage and smaller yield. Aside from this Sample, however, no major differences were noted among the other Samples. Consequently, although young seedlings transplanted early tend to yield slightly higher, differences are not highly significant. As long as seedlings between 25- and 45-days-old are employed, no big differences in yield should be expected.

Figure #9: Yield and plant characteristics



## Testing of the 1970 dry season wet rice crop

Just as the dry season wet rice crop test plan was being completed, owing to rat and stem borer damage, the Director of the Center was hesistant to start work. With that, the Cambodian controllers lost their resolve to conduct testing. After some persuasion, however, it was decided that some testing, limited to fertilizer quantities on the wet rice crop and seedling growth periods, would be conducted.

Damage from rat infestation, the cause of initial fears, proved uncontainable and testing, though already underway, had to be abandoned in midstream.

Stem borer infestation, though likewise severe, was finally prevented by applying Gamma-BHC in pellet form. However, by the middle of April, rat infestation was getting worse by the day. To give the reader an idea of the severity of the infestation, 50 - 90 rats a day were being killed by the electrified fences surrounding the test fields. On one rainy morning, the numbers exceeded 100. Up to the middle of April, we had somehow been able to contain the damage, but after that it gradually grew worse. As rainfall grew heavier, 'rat patrol' got more and more lax. Moreover, as political changes unfolded in the country, the laborers' tended to slough off even more than usual. Finally, when the battery powering the electric fence was improperly replaced, the rats took advantage of the lull in vigilance to invade and destroy the fields. Although the Japanese staff planned to try combating the rats to the bitter end, this proved futile and the damage caused by rats only grew in severity. By the end of April we were forced to abandon some fields. As the damage grew worse, we were faced with the possibility that there would be no crops left to survey. Regrettably, on May 11, all crop testing had to be abandoned.

## Soil and Fertilizer Department

### 1. Testing to determine the optimal quantities of nitrogenous fertilizer and the timing of application for rice cultivation

1) Objective:
To determine, under varying soil conditions, the optimal method for applying nitrogenous fertilizer in the cultivation of native rice species.

2) Period of testing: Three years

3) Test plan

In groups of four

Meaning of symbols used below:
N1 and P1 signify N 30kg/ha and P205 30kg/ha. The nitrogenous fertilizer is urea and the phosphatic fertilizer was domestically produced in Tuk Meus.

The fertilizer application plan for each test plot is as follows:

(1) N1,P1 -- applied prior to seedling transplantation
(2) N1/2,P1 -- applied prior to seedling transplantation
N1/2 -- applied 30 days prior to earing (2 months after transplantation)
(3) N1/2,P1 -- applied prior to seeding transplantation
N1/2 -- applied prior to earing
(4) N1/3,P1 -- applied prior to seedling transplantation
N2/3 -- applied when earing begins
(5) N1/3,P1 -- applied prior to seedling transplantation
N1/3 -- applied when tillering begins
N1/3 -- applied when earing begins
(6) -- unfertilized plot

Test varieties
4 varieties -- (A) Kong Khsach
(B) Neang Menh
(C) Srauv Koul
(D) Chhuthana

Test sites (7 locations)
* Prey Veng
* Prey Thnot
* Banan
* Kauk Trap (both sandy and alumy soils)
* Slakou (Takeo)
* Tuol Samron (the Center)
* Kauk Patry

Method of cultivation:
Tilling methods and the timing for planting were all in accordance with local practices.

Transplantation:
Done when seedlings had developed 5 - 6 leaves

Distance between plants:
20cm x 20cm, each transplanted clump with three seedlings.

Items for observation:
Start and finish of the earing process, start and finish of the ripening process

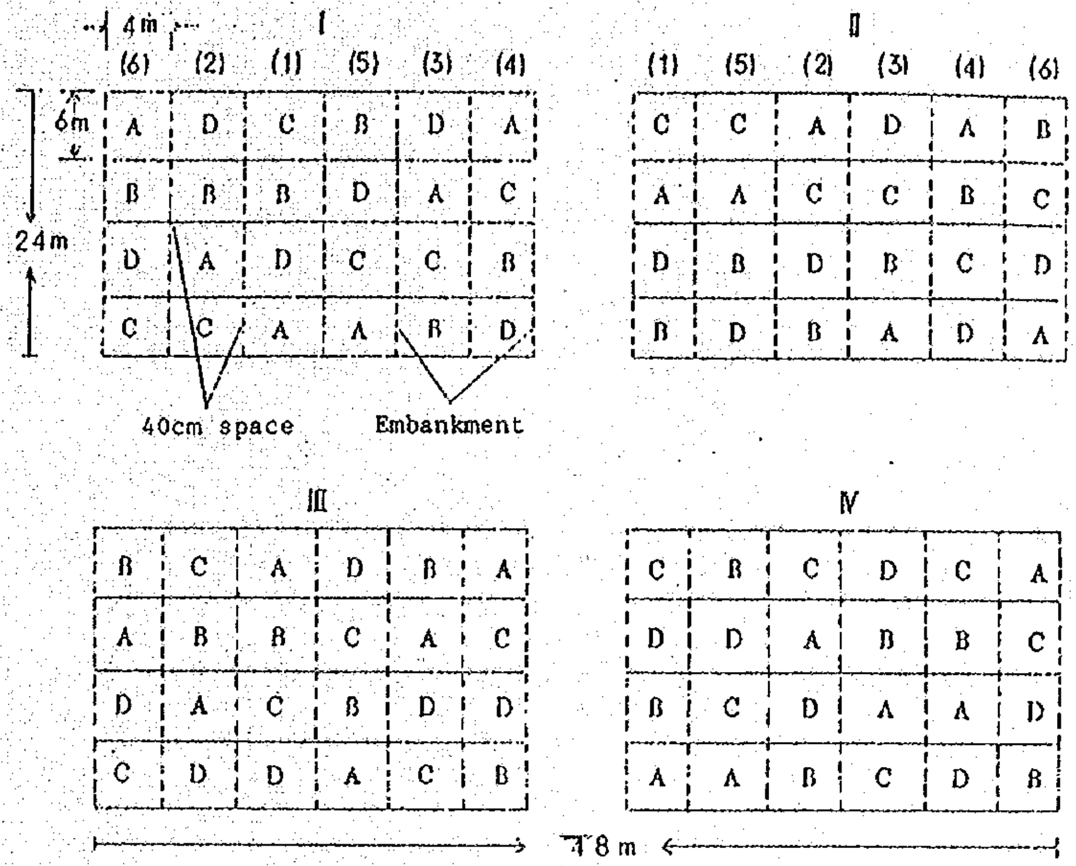
Timing of direct sowing, transplantation and fertilizer application, tillering timing, number of tillers, plant height

Rooting conditions: New leaf growth, recovery condition
Existence of plant diseases and pests
Changes in the growth process, yellowing, or other notable phenomena

Harvest time
Grain: Weight of immature (unharvested) grain
Weight of empty grain husks
Dry weight

Straw: (cut at a height of 20cm)
Raw straw weight
Dry straw weight

## Layout of test plots



I

| (6) | (2) | (1) | (5) | (3) | (4) |
|---|---|---|---|---|---|
| A | D | C | B | D | A |
| B | B | B | D | A | C |
| D | A | D | C | C | B |
| C | C | A | A | B | D |

II

| (1) | (5) | (2) | (3) | (4) | (6) |
|---|---|---|---|---|---|
| C | C | A | D | A | B |
| A | A | C | C | B | C |
| D | B | D | B | C | D |
| B | D | B | A | D | A |

III

| | | | | | |
|---|---|---|---|---|---|
| B | C | A | D | B | A |
| A | B | B | C | A | C |
| D | A | C | B | D | D |
| C | D | D | A | C | B |

IV

| | | | | | |
|---|---|---|---|---|---|
| C | B | C | D | C | A |
| D | D | A | B | B | C |
| B | C | D | A | A | D |
| A | A | B | C | D | B |

4) Test results

Table #1: Survey of the .MDNM/number of offshoots over time

Divided according to fertilizer application method

|  | Survey month/day<br>Variety | Aug. 30/ VII | 8/IX | 15/IX | 22/IX | 29/IX | 6/X | 13/X | 20/X | 27/X | 3/XI | 11/XI | 17/XI | 24/XI | 1/XII | 8/XII |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | A<br>Kong Khsach | Tillers<br>5.35 | 6.88 | 7,13 | 7.68 | 7.03 | 6.15 | 5.73 | 5.98 | 5.45 | 5.78 | 5.25 | 5.08 | 4.80 | 4.95 | 4.98 | 5.30 |
|  | B<br>Neang Menh | 3.63 | 6.30 | 6.60 | 5.90 | 6.23 | 5.98 | 5.38 | 5,13 | 5.20 | 4.90 | 4.80 | 4,70 | 4,73 | 4.60 | 4.50 | 5.20 |
|  | C<br>Srauv Koul | 5.13 | 7,65 | 7.65 | 6.70 | 6.90 | 6.75 | 6.55 | 5.65 | 5.90 | 6.20 | 5.80 | 5.60 | 5.25 | 5.43 | 5.68 | 6,13 |
|  | D<br>Chhuthana | 3.95 | 5,05 | 5.33 | 5.70 | 5.53 | 4.73 | 4.35 | 4.45 | 4.13 | 3.93 | 3.83 | 3.43 | 3.60 | 3,50 | 3.43 | 3.40 |
| 2 | A | 5,25 | 6,58 | 7,45 | 6.98 | 7.28 | 6.40 | 5.78 | 5.55 | 5.28 | 5.33 | 5.15 | 5.20 | 4.93 | 4.90 | 5.15 | 4,75 |
|  | B | 4.20 | 6.13 | 6.80 | 65.5 | 6.20 | 5,38 | 5,90 | 5.30 | 5.08 | 4.78 | 4.45 | 4.68 | 4,80 | 4.33 | 4.35 | 5.20 |
|  | C | 5.80 | 7.38 | 8.00 | 7.98 | 7.05 | 6.73 | 6.05 | 5.88 | 6.13 | 5.90 | 5.60 | 5.50 | 5.30 | 5.73 | 5.05 | 5.45 |
|  | D | 4.65 | 5.53 | 5.43 | 5.30 | 5.03 | 4,68 | 4.50 | 4.35 | 4.23 | 4.83 | 4.18 | 3.78 | 3.90 | 3.90 | 3.98 | 3.95 |
| 3 | A | 5,28 | 7.28 | 7.58 | 8.05 | 6.68 | 6.33 | 5.75 | 5.63 | 5.15 | 5.10 | 5.23 | 4.98 | 4.70 | 5.10 | 4.63 | 5.13 |
|  | B | 4,58 | 6.28 | 6.55 | 6,68 | 6.28 | 5.90 | 5.45 | 5.18 | 5.45 | 5,03 | 4.60 | 4,40 | 4.33 | 4.55 | 4.20 | 5.03 |
|  | C | 5.15 | 7.33 | 7,73 | 7.33 | 6.83 | 6.83 | 5.23 | 5.48 | 5.43 | 5.18 | 5.40 | 5.35 | 5,00 | 5.10 | 4.93 | 4.93 |
|  | D | 4.10 | 5.78 | 5.90 | 5.95 | 5.05 | 4.55 | 4.53 | 4.38 | 4.43 | 4.15 | 4.15 | 4.08 | 4,08 | 4.20 | 3.65 | 3.85 |
| 4 | A | 5,53 | 7,35 | 7.73 | 7.73 | 6.50 | 6.15 | 5.60 | 5.30 | 5,25 | 5.60 | 5.35 | 5.40 | 5.23 | 4.78 | 4.80 | 4.60 |
|  | B | 4.25 | 6,00 | 6.43 | 6.10 | 5.20 | 5.30 | 5.30 | 5.15 | 4.90 | 4.40 | 4.63 | 4.58 | 4.13 | 4.45 | 4.43 | 5.25 |
|  | C | 5.13 | 7.03 | 7.50 | 7.58 | 6.95 | 6.58 | 5.88 | 5.68 | 5.58 | 5.73 | 5.73 | 5.43 | 5.38 | 5.03 | 5.10 | 5.58 |
|  | D | 4.50 | 5.15 | 5.13 | 5.43 | 5.65 | 4.43 | 4.13 | 4.08 | 3.95 | 3.78 | 3.70 | 3.55 | 3.48 | 3.45 | 3.38 | 3.25 |
| 5 | A | 5.23 | 7.00 | 8.03 | 6.83 | 6.23 | 6.10 | 5.93 | 5.98 | 5.43 | 5.33 | 5,00 | 5.10 | 5.05 | 5.00 | 4.85 | 5.25 |
|  | B | 4.20 | 5.95 | 6.35 | 6.15 | 6.15 | 5.28 | 4.85 | 5,35 | 5.15 | 5.40 | 4.63 | 4.75 | 4.35 | 4.50 | 4.30 | 5.20 |
|  | C | 4.85 | 6.15 | 6,98 | 6.70 | 6,50 | 5.95 | 5.63 | 5.30 | 5.15 | 5.10 | 4.95 | 4.95 | 4.80 | 4.48 | 4.78 | 5.43 |
|  | D | 3.65 | 5.00 | 5.05 | 4.78 | 4.60 | 4.48 | 4.28 | 4.05 | 4.00 | 4.78 | 3.75 | 3.55 | 3.83 | 3.65 | 3.43 | 3.45 |
| 6 | A | 3.23 | 4.58 | 5.50 | 5.23 | 5.20 | 4.83 | 4.63 | 4.23 | 4.05 | 4.23 | 4.08 | 4.13 | 4.23 | 4.05 | 3.98 | 4.85 |
|  | B | 2.93 | 3.53 | 4.38 | 3,80 | 4.53 | 3.85 | 3.50 | 3.68 | 3.70 | 3.53 | 3.53 | 3.48 | 3.38 | 3.48 | 3.55 | 5.00 |
|  | C | 3.25 | 4.60 | 5,65 | 5.08 | 4,98 | 4.25 | 4.30 | 4.23 | 4.20 | 4.28 | 4.25 | 4.33 | 4.10 | 3.80 | 3.93 | 4.90 |
|  | D | 2.75 | 3.28 | 3.53 | 4,05 | 4.68 | 3,35 | 3.58 | 3.20 | 3.65 | 3,00 | 3.00 | 2.95 | 2.93 | 3.03 | 2.80 | 2.68 |

Note: Each statistic on the number of offshoots is an average from four plots: I, II, III, IV.

Table #2: Survey of plant height, rough rice weight and straw weight

Divided according to fertilizer application method

| | Item<br>Variety | Plant height at maturity | Straw weight (kg) | | Rough rice weight (g) | | |
|---|---|---|---|---|---|---|---|
| | | | Raw weight | Dry weight | Raw weight | Dry weight | Ratio |
| 1 | A<br>Kong Khsach | 141.18 | 8.46 | 2.24 | 2.74 | 2.23 | 81.4 |
| | B<br>Neang Menh | 139.43 | 6.74 | 1.99 | 2.76 | 2.42 | 87.7 |
| | C<br>Srauv Koul | 140.25 | 9.10 | 2.80 | 3.12 | 2.67 | 85.6 |
| | D<br>Chhuthana | 123.43 | 9.16 | 3.41 | 2.37 | 1.97 | 83.1 |
| 2 | A | 146.93 | 8.59 | 2.71 | 2.84 | 2.11 | 74.3 |
| | B | 145.30 | 6.09 | 1.59 | 2.81 | 2.46 | 74.3 |
| | C | 151.48 | 8.26 | 3.02 | 3.29 | 2.82 | 85.7 |
| | D | 127.73 | 8.87 | 3.43 | 2.51 | 2.15 | 85.7 |
| 3 | A | 139.83 | 8.10 | 1.93 | 2.68 | 2.43 | 90.7 |
| | B | 137.85 | 5.44 | 1.61 | 2.94 | 2.62 | 89.0 |
| | C | 139.23 | 7.88 | 2.52 | 2.96 | 2.59 | 87.2 |
| | D | 129.45 | 8.40 | 2.92 | 2.52 | 2.22 | 88.1 |
| 4 | A | 139.88 | 7.53 | 2.13 | 2.52 | 2.30 | 91.3 |
| | B | 144.53 | 5.80 | 1.61 | 2.90 | 2.55 | 87.9 |
| | C | 141.95 | 7.39 | 2.63 | 2.83 | 2.42 | 85.5 |
| | D | 122.60 | 7.22 | 2.78 | 2.14 | 1.85 | 86.4 |
| 5 | A | 144.20 | 7.05 | 2.04 | 2.28 | 2.07 | 90.8 |
| | B | 143.73 | 6.24 | 1.80 | 2.71 | 2.37 | 87.5 |
| | C | 135.23 | 7.15 | 1.97 | 2.68 | 2.16 | 80.6 |
| | D | 121.30 | 7.27 | 2.80 | 2.28 | 1.90 | 83.3 |
| 6 | A | 135.15 | 5.55 | 1.47 | 1.95 | 1.66 | 85.1 |
| | B | 136.50 | 4.12 | 1.21 | 1.96 | 1.63 | 83.2 |
| | C | 132.45 | 5.12 | 1.89 | 2.11 | 2.07 | 98.1 |
| | D | 106.18 | 4.35 | 1.40 | 1.47 | 1.15 | 78.2 |

Note: Each statistic is an average for four plots: I, II, III, IV and represents the harvest from 20 square meters of field.

5) Observations

- This year, no significant differences in yield were observed as a result of the partial application method used to apply nitrogenous fertilizer.

- However, nitrogenous fertilizer applied either directly before earing or at the start of earing does seem to have a positive effect on the harvest.

- Aside from the Srauv Koul variety, a half application of nitrogenous fertilizer right before earing (as shown in (3) of the fertilizer application plan above) contributed significantly to a better yield. Consequently, supplemental application of nitrogenous fertilizer during the latter growth period positively impacts both yield and ripening rate.

- In accordance with directives from the Central Government, this test is to run continuously for three years. Although the results obtained last year should be considered alongside those from this year, the data are unfortunately not available to us. Once we have the results for the third and last year in hand, we should be in a position to draw some final conclusions.

- Due to the heavy rains which occurred at the end of September, not only the test plots but the whole rice crop at the Center was flooded. This can be expected to introduce inconsistencies in our results, particularly those from low lying paddy and fields planted in short stemmed rice which sustained considerable flood damage.

- In terms of damage from plant disease, a portion of the crop was infested slightly with bacterial leaf blight.

2. Comparison of the effectiveness of Tuk Meas Phosphate and Hyperphosphate on the rainy season rice crop

1) Objectives

a. To compare the effects of Tuk Meas Phosphate and Hyperphosphate during flood conditions.

b. To compare conventional practices for applying fertilizer with improved application methods.

-- Testing is mandated to continue for a period of three years (this is the final year).

2) Test sites

| Region | Soil type |
|---|---|
| (1) Takeo (Slakou) | Alluvial soils |
| (2) Prey Veng (Secteur Agricole) | Alluvial or Cultural Hydromorphics |
| (3) Svay Rieng (Kauk Trap) | Alluvial soils |
| (4) Kompong Speu (S.A.) | Cultural Hydromorphics |
| (5) Siemreap (Kauk Patry) | Cultural Hydromorphics |
| (6) Kompong Cham (S.A.) | Black Soils; Basaftic Requr |
| (7) Kompong Thom (S.A.) | Cultural Hydromorphics soils |
| (8) Kompong Chhnang (S.A.) | Cultural Hydromorphics soils |
| (9) Pursat (S.A.) | Grey Hydromorphics |
| (10) Battambang (Tuol samrong) | Brown Hydromorphics |
| (11) Kampot (Prey Nop) | Mangrove |

Note: Site (10) is the Khmer-Japanese Friendship Agricultural Technical Center.

3) Test plan

N1: 30kg/ha of nitrogenous fertilizer (urea)
N2: 60kg/ha of nitrogenous fertilizer (urea)
T1: 120kg/ha of phosphatic fertilizer (phosphates domestically produced in Tuk Meas)
T2: 240kg/ha of phosphatic fertilizer (phosphates domestically produced in Tuk Meas)
H1: 120kg/ha of phosphatic fertilizer (Hyperphosphate)
H2: 240kg/ha of phosphatic fertilizer (Hyperphosphate)

(1) The fertilizer application plan for each test plot is as follows:

| Test plot | Description |
|---|---|
| 1 | No fertilizer applied |
| 2 | N1T1 - 30kg N + 120 kg $P_2O_5$ Tuk Meas /ha |
| 3 | N1T2 - 30kg N + 240 kg $P_2O_5$ Tuk Meas /ha |
| 4 | N1H1 - 30kg N + 120 kg $P_2O_5$ Hyperphosphate /ha |
| 5 | N1H2 - 30kg N + 240 kg $P_2O_5$ Hyperphosphate /ha |
| 6 | N2T1 - 60kg N + 120 kg $P_2O_5$ Tuk Meas /ha |
| 7 | N2T2 - 60kg N + 240 kg $P_2O_5$ Tuk Meas /ha |
| 8 | N2H1 - 60kg N + 120 kg $P_2O_5$ Hyperphosphate /ha |
| 9 | N2H2 - 60kg N + 240 kg $P_2O_5$ Hyperphosphate /ha |

Varieties: One variety normally planted in each region during that time of year was adopted. At the Center, the Kong Khsach variety was employed.

Layout of test plots

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| N1T1<br>2 | N1H1<br>4 | N2H2<br>9 | N2T2<br>7 | No fertilizer applied<br>1 | | N2T1<br>6 | N2H1<br>8 | N1H2<br>5 | N1T2<br>3 |
| No fertilizer applied<br>1 | | N2H1<br>8 | N2T1<br>6 | N1H2<br>5 | N1T2<br>3 | N2T2<br>7 | N2H2<br>9 | N1H1<br>2 | N1T1<br>4 |
| N2T2<br>7 | N2H2<br>9 | N1H2<br>5 | N1T2<br>3 | N1H1<br>4 | N1T1<br>2 | No fertilizer applied<br>1 | | N2T1<br>6 | N2H1<br>8 |
| N2T1<br>6 | N2H1<br>8 | N1T1<br>2 | N1H1<br>4 | N2T2<br>7 | N2H2<br>9 | N1H2<br>5 | N1T2<br>3 | No fertilizer applied<br>1 | |
| N1T2<br>3 | N1H2<br>5 | No fertilizer applied<br>1 | | N2T1<br>6 | N2H1<br>8 | N1H1<br>4 | N1T1<br>2 | N2H2<br>7 | N2T2<br>9 |

Spacing of 50cm

Embankment

Plots were cultivated in groups of five.

a. Number of plots: 25, each 8m x 8m
b. Each test plot has 50 divisions, each 4m x 8m
c. Sowing time: The regular sowing time for each region.
d. Transplantation: Done when seedlings had developed 5-6 leaves.
e. Distance between plants: 20cm x 20cm
f. Each clump has three plants
g. Fertilizer application method

1) A portion of the N and all of the P2O5 were applied prior to seedling transplantation and distributed as evenly as possible in the fields.

2) Partial application of N:

1/3 applied along with all the P2O5 just before transplantation.
1/3 applied during the tillering period.
1/3 applied 30 days prior to earing

Items for observation:

- Sowing period, transplantation period, earing and maturation period, fertilizer application times
- Rooting conditions
- Comparison of resistance to plant diseases
- Signs of yellowing
- Number of offshoots (accurately noting the time of observation)
- Straw weight per hectare (cut at a height of 20cm)
- Rough rice weight per hectare

4) Test results

Table #1: Survey of the .MDNM/number of offshoots over time

| Test plots | Month/day of survey | 22/VIII | 29/VIII | 6/IX | 13/IX | 22/IX | 27/IX | 6/X | 13/X | 20/X | 27/X | 3/XI | 11/XI | 17/XI | 24/XI | 1/XII | 8/XII |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | No fertilizer | 4.95 | 5.30 | 6.01 | 6.55 | 6.25 | 5.72 | 5.96 | 5.48 | 5.23 | 5.12 | 5.08 | 5.05 | 4.61 | 4.84 | 4.99 | 4.72 |
| 2 | N1T1 | 9.32 | 9.08 | 9.30 | 8.98 | 8.58 | 8.10 | 7.70 | 7.24 | 7.24 | 6.36 | 7.32 | 7.04 | 5.98 | 6.78 | 6.80 | 6.48 |
| 3 | N1T2 | 9.34 | 8.70 | 9.00 | 8.76 | 8.10 | 7.66 | 7.22 | 7.38 | 7.04 | 6.76 | 6.94 | 7.18 | 5.94 | 6.46 | 6.50 | 6.18 |
| 4 | N1H1 | 9.62 | 9.22 | 9.48 | 9.78 | 8.66 | 8.20 | 8.24 | 8.14 | 7.80 | 7.40 | 7.84 | 7.24 | 6.22 | 6.78 | 6.86 | 6.78 |
| 5 | N1H2 | 9.72 | 9.22 | 9.45 | 9.20 | 8.52 | 7.70 | 7.40 | 7.10 | 6.98 | 6.92 | 7.28 | 7.16 | 6.42 | 6.84 | 6.70 | 6.58 |
| 6 | N2T1 | 9.86 | 9.56 | 9.42 | 9.42 | 9.02 | 8.44 | 8.06 | 7.82 | 7.32 | 7.32 | 7.80 | 7.24 | 6.54 | 6.62 | 6.80 | 6.80 |
| 7 | N2T2 | 10.16 | 9.72 | 9.72 | 9.57 | 9.24 | 8.84 | 8.64 | 8.14 | 7.94 | 7.46 | 7.80 | 7.54 | 7.88 | 7.00 | 7.16 | 7.18 |
| 8 | N2H1 | 9.46 | 9.82 | 10.20 | 9.82 | 9.34 | 8.70 | 8.34 | 7.96 | 7.30 | 7.28 | 7.42 | 7.46 | 6.26 | 6.80 | 6.68 | 6.98 |
| 9 | N2H2 | 9.68 | 8.98 | 9.34 | 9.26 | 8.50 | 7.92 | 7.82 | 7.48 | 7.48 | 7.34 | 7.98 | 7.94 | 6.66 | 7.10 | 7.34 | 7.34 |

Note: The number of offshoots is derived by averaging the various blocks.

Table #2: Survey of plant height, rough rice weight and straw weight

| Test plots | Servey item | Plant height cm | Straw weight (kg) | | Rough rice weight (kg) | | |
|---|---|---|---|---|---|---|---|
| | | | Raw weight | Dry weight | Raw weight | Dry weight | Ratio |
| 1 | No fertilizer | 121.03 | 6.26 | 1.69 | 2.33 | 1.93 | 82.8 % |
| 2 | N1T1 | 145.08 | 12.05 | 3.00 | 3.92 | 3.30 | 84.2 |
| 3 | N1T2 | 143.54 | 12.44 | 3.37 | 3.98 | 3.41 | 85.7 |
| 4 | N1H1 | 148.02 | 12.98 | 3.22 | 3.76 | 3.36 | 89.4 |
| 5 | N1H2 | 142.45 | 11.70 | 3.52 | 3.74 | 3.21 | 85.8 |
| 6 | N2T1 | 150.54 | 13.13 | 3.12 | 5.08 | 3.58 | 70.5 |
| 7 | N2T2 | 149.78 | 14.11 | 3.50 | 5.03 | 3.52 | 70.0 |
| 8 | N2H1 | 150.56 | 14.29 | 3.75 | 5.09 | 3.55 | 69.7 |
| 9 | N2H2 | 149.58 | 14.12 | 3.69 | 5.00 | 3.62 | 72.4 |

Note: Statistics represent an average of five blocks. Each block harvested has an area of 20 square meters.

Partial results of soil analysis conducted after harvesting are shown below.

Table #3: Soil PH and effective quantities of residual phosphate in harvested fields

| Servey item / Test plots | | PH | | Effective phosphate (mg per 100g) | Nitrogen | Potassium |
|---|---|---|---|---|---|---|
| | | $H_2O$ | KCl | | | |
| 1 | No fertilizer | 5.50 | 3.35 | 0.125 | | |
| 2 | N1T1 | 5.50 | 3.35 | 0.5 | | |
| 3 | N1T2 | 5.35 | 3.40 | 1.5 | | |
| 4 | N1H1 | 5.55 | 3.40 | 1.5 | | |
| 5 | N1H2 | 5.50 | 3.40 | 0.5 | | |
| 6 | N2T1 | 5.40 | 3.40 | 0.5 | | |
| 7 | N2T2 | 5.40 | 3.35 | 0.5 | | |
| 8 | N2H1 | 5.62 | 3.30 | 0.25 | | |
| 9 | N2H2 | 5.45 | 3.40 | 0.5 | | |

Note: Unfortunately, data on nitrogen, potassium and other soil consituents are not available because the analysis was abandoned midway through.

5) Observations

- As far as fertilizer effectiveness is concerned, as Table #2 makes clear, almost no differences were observed between Tuk Meas Phosphate and Hyperphosphate.

- Yield (rough rice weight) comparisons

N2T1/N1T1= 108   N2T2/N1T2= 103   N2H1/N1H1= 106   N2H2/N1H2= 112

N1T2/N1T1= 103   N2T2/N2T1= 98   N1H2/N1H1= 96   N2H2/N2H1= 102

On the basis of the first set (upper tier) of yield comparisons, increasing the application of nitrogen will increase yield. Where the same quantity and quality of phosphatic fertilizer are applied, and N1 (30kg/ha) yield is assigned a value of 100, N2 (60kg/ha) results in yields, as shown above, of 108, 103, 106 and 112, respectively.

On the basis of the second set (lower tier) of yield comparisons, where the same quantity and quality of nitrogenous fertilizer are applied, and T1, H1 are assigned a value of 100, N1 plus T2 yields 103, N1 plus H2 yields 96, N2 plus T2 yields 98 and N2 plus H2 yields 102. In other words, increasing the quantity of phosphatic fertilizer has almost no effect on yield. These test results allow us to conclude that 120kg/ha of phosphatic fertilizer are sufficient.

- The soil in fields which have been recently harvested tends to be on the acid side. Although residual phosphates are still present in the soil as compared with fields in which no fertilizer was applied, (as shown in Table #3), quantities are small. It is common knowledge that the phosphate content of Cambodian soils is extremely low. Furthermore, with respect to the problem of residual phosphates in the soil after heavy phosphatic fertilizer applications, further study is needed.

## 3. Testing the economic viability of the Neang Menh variety

### 1) Objectives

- Create a curve which correlates the quantities of nitrogen applied and economic viability.

- Create a curve charting the effectiveness of fertilizer application.

### 2) Test plan

- Location: C.T.A. (Agricultural Center)
- Soil type: Brown hydromorphic
- Test variety: Neang Menh

- Sowing
  Quantity of seed sown: 100g per square meter
  Fertilizer: N 0.5, P205 1.5, K20 1.5/kg per a

- Seedling transplantation
  Transplantation timing: When seedlings have 5-6 leaves
  Distance between plants: 15 x 25cm, 3 seedlings per clump
  Otherwise, routine transplantation techniques applied.

- The design of the test plots is as follows:

(Kg/Ha)

| | N | $P_2O_5$ | $K_2O$ |
|---|---|---|---|
| 1. — No fertilizer | 0 — | 0 — | 0 |
| 2. — N1P2 | 30 — | 60 — | 0 |
| 3. — N2P2 | 60 — | 60 — | 0 |
| 4. — N3P2 | 90 — | 60 — | 0 |
| 5. — N4P2 | 120 — | 60 — | 0 |
| 6. — N5P2 | 150 — | 60 — | 0 |

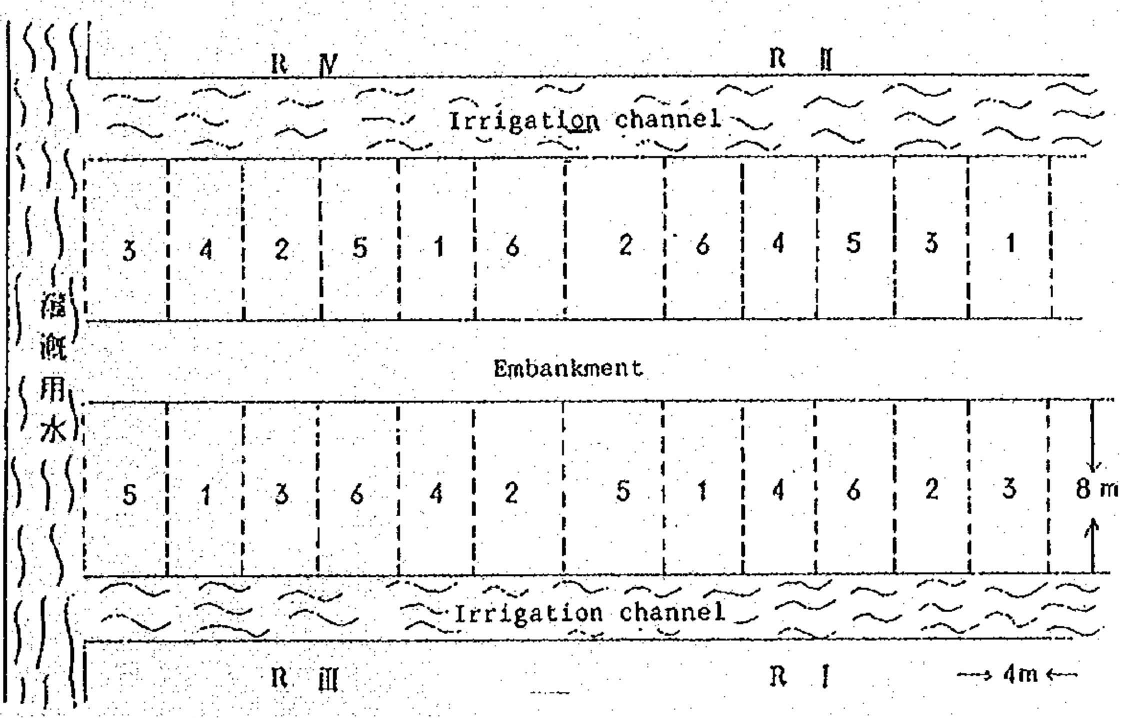
Quantities of nitrogenous fertilizer applied during various phases of the growth process as follows:

| Plot | Prior to transplantation | At the start of tillering | At earing |
|---|---|---|---|
| 1 | 0 | 0 | 0 |
| 2 | 10 | 10 | 10 |
| 3 | 30 | 15 | 15 |
| 4 | 50 | 20 | 20 |
| 5 | 60 | 40 | 20 |
| 6 | 80 | 50 | 20 |

Note: The nitrogenous fertilizer applied is urea. The phosphatic fertilizer applied is Tuk Meas Hyperphosphate.

The test plots were set up in fours as shown below.

[Layout of test plots]



Items for observation:

- Sowing period
- Transplantation period
- Tillering period
- Earing period
- Number of offshoots
- Number of ears
- Grain weight per ear
- 1000-grain weight
- Dry rough rice weight
- Dry straw weight

3) Test results

Table #1: Survey of the .MDNM/number of offshoots over time

| Test plots | Month/day of survey | 3/IX | 18/IX | 3/X | 18/X | 4/XI | 18/XI | 2/XII |
|---|---|---|---|---|---|---|---|---|
| 1 | No fertilizer | 3.65 | 5.80 | 4.60 | 4.32 | 4.17 | 4.02 | 3.82 |
| 2 | N1P2 | 5.87 | 8.05 | 6.25 | 5.65 | 5.87 | 4.87 | 4.85 |
| 3 | N2P2 | 6.80 | 8.27 | 7.05 | 6.62 | 6.25 | 5.35 | 5.47 |
| 4 | N3P2 | 7.32 | 9.50 | 7.55 | 7.00 | 6.47 | 5.70 | 5.60 |
| 5 | N4P2 | 7.95 | 9.47 | 7.45 | 7.22 | 6.40 | 6.20 | 6.22 |
| 6 | N5P2 | 7.35 | 9.40 | 7.75 | 7.07 | 6.85 | 6.20 | 5.75 |

Note: The statistics on number of offshoots cited in the Table represent averages from four locations.

Table #2: Yield survey

| Test plots | Month/day of survey | Raw straw weight | Dry straw weight | Raw rough rice weight | Dry rough rice weight |
|---|---|---|---|---|---|
| 1 | No fertilizer | 3,640 kg | 1,890 | 2,915 | 2,608 |
| 2 | N1P2 | 3,755 | 2,075 | 2,815 | 3,418 |
| 3 | N2P2 | 4,715 | 2,603 | 4,150 | 3,745 |
| 4 | N3P2 | 5,045 | 2,940 | 4,780 | 4,375 |
| 5 | N4P2 | 5,815 | 3,248 | 4,775 | 4,340 |
| 6 | N5P2 | 5,925 | 3,288 | 5,120 | 4,658 |

Note: Figures in the Table are based on an average from four locations. Harvesting was done in 20 square meter sections.

The results of soil analysis performed after the harvest are shown in the following Table.

Table #3: Soil PH and residual phosphate in recently harvested fields

| Test plots \ Servey item | | PH | | Effective phosphate residue mg/100g | Nitrogen | Potassium |
|---|---|---|---|---|---|---|
| | | $H_2O$ | KCl | | | |
| 1 | No fertilizer | 5.10 | 3.40 | 0.5 | | |
| 2 | N1P2 | 5.35 | 3.40 | 0.5 | | |
| 3 | N2P2 | 5.50 | 3.40 | 0.5 | | |
| 4 | N3P2 | 5.35 | 3.40 | 0.5 | | |
| 5 | N4P2 | 5.15 | 3.50 | 0.5 | | |
| 6 | N5P2 | 5.10 | 3.50 | 1.0 | | |

4) Observations

- According to the Yield Survey (Table #2), there is generally a proportional relationship between the quantities of nitrogenous fertilizer applied and increased yield. Nevertheless, the N3 and N4 plots had more or less equivalent yields in spite of the greater nitrogen application in N4, while the yield increase noted in N5 is not that large. From the standpoints of economy and efficient utilization of fertilizer resources, as past testing has shown, quantities up to the N3 level can be considered optimal.

- Although extremely large quantities of nitrogenous fertilizer were employed in the N4 (120kg/ha) and N5 (150kg/ha) plots, there was very little plant collapse this year. To explore the reasons for this, we set out to measure nitrogen residues in the harvest fields. Unfortunately, however, soil analysis work had to be canceled in midstream.

- With respect to the utilization efficiency of nitrogen, in one of the previous tests, "1. Testing to determine the optimal quantities of nitrogenous fertilizer and the timing of application for rice cultivation", the final quantity of nitrogenous fertilizer applied to each test plot was identical. Although these results are of concern to us, further testing is needed to consider questions like fertilizer utilization efficiency when larger amounts of nitrogenous fertilizer are applied along with the timing of application and the varying amounts to be employed in multiple applications.

## Agricultural Machinery Department

The testing conducted on the 1969 rainy season rice crop was heavily impacted by the extraordinary high water and subsequent flooding which occurred in September 1969, right around the time of our arrival in Cambodia. Flooding impacted testing on cultivation methods for native species, fertilizer application results, testing on the application of nitrogenous fertilizers, and the testing of direct sowing and row sowing. Because the flooding in the fields being worked by the Agricultural Machinery Department was particularly persistent and damage extensive, it was impossible in some instances to obtain any useful data at all. In the case of the row sowing test, for instance, the weed invasion was so devastating that no data worth studying could be obtained. As a result, the only test for which the Agricultural Machinery Department could obtain results during the 1969 rainy season rice crop was the combine-aided harvest survey. (Test results could also not be obtained for the dry season crop, due to inadequate rat prevention resources for the machine-cultivated fields.)

### 1. Combine-aided harvest survey

#### 1) Machinery employed:

Massey Ferguson Combine 39 -- Semi-crawler type with diesel engine and 4 cylinder 40.5 BHP (2980 RPM)

Reaping width: 2m

Chaff sheaf and flexible control sheaf employed

Grain sheaf No. 2
* Wind powered cylinder concave gap is adjusted each time by means of a control lever.

Table #1

| | | Variety Reaping month/day / Survey item | Neang Menh Srauv 1969 12.9 | Kong Khsach 1969 12.15 | Pkhar Srauv 1970 1.5 | Neang Menh Ton 1970 1.12 | I R 5 1970 1.21 |
|---|---|---|---|---|---|---|---|
| Field conditions | | Plant height (cm) | 120 | 117 | 112 | 130 | 90 |
| | | Degree of collapse (standing angle of plants to be harvested) | 40 - 45 | 70 - 75 | 70 - 75 | 70 - 75 | 80 - 90 |
| | | Rough rice moisture content % | | 19 | | 13.5 | |
| | | Straw moisture content % | | | | | |
| | | Field hardness kg/cubic cm | | | 5 | 20 | 5 |
| Operational conditions | | Operating speed cm/sec | 25 | 41 | 50 | 45 | 45 |
| | | Cylinder speed - idling RPMs | 490 | 490 | 490 | 490 | 490 |
| | | Effecting reaping width (cm) | 193 | 194 | 190 | 190 | 190 |
| | | Average reaping height cm | 25 | 50 | 35 | 38 | 23 |
| Survey results 100% | Grain kernel statistics | No. of grain kernels | | 95.1 | 96.5 | 94.0 | 90.0 |
| | | Broken kernels | | 1.2 | 0.8 | 2.0 | 1.3 |
| | | Empty husks, straw refquse, etc. | | 2.4 | 1.2 | 3.0 | 6.6 |
| | | Loss due to straw rack | | 1.1 | 1.0 | 0.8 | 1.9 |
| | | Loss due to chaff shea | | 0.2 | 0.5 | 0.2 | 0.2 |

2) Calculation of combine costs

Combine purchase price: 580,000 riels (The exchange rate at the time of purchase was US$1 = 35 riels. The present exchange rate is US$1 = 55 riels.)

Average reaping efficiency: 7 hours per hectare
Calculations are based on a combine service life of 2,500 hours.

Table #2

| Yearly use hours | | | 300 | 500 | 700 | 1,000 |
|---|---|---|---|---|---|---|
| Yearly machine (HA) cultivated area | | | 43 | 72 | 100 | 143 |
| Equipment service life | | | 8 | 5 | (approx.) 4 | (approx.) 3 |
| Yearly fixed expenses | | Depreciation | 68,875 | 110,200 | 137,450 | 183,667 |
| | | Capital interest | 17,400 | 17,400 | 17,400 | 17,400 |
| | | Building (garaging) expenses | 500 | 500 | 500 | 500 |
| | | Taxes and levies | 4,060 | 4,060 | 4,060 | 4,060 |
| | | Total | 90,835 | 132,160 | 159,410 | 205,627 |
| Hourly equipment costs | | Fixed expenses | 303 | 264 | 228 | 206 |
| | Variable expenses | Repair costs | 174 | 174 | 174 | 174 |
| | | Fuel costs | 18 | 18 | 18 | 18 |
| | | Lubricant costs | 1 | 1 | 1 | 1 |
| | | Personnel expenses | 10 | 10 | 10 | 10 |
| | | Total | 506 | 467 | 431 | 409 |
| Equipment costs per hectare | | | 3,542 | 3,269 | 3,017 | 2,863 |

Unit: riels

Repairs costs (per hour) Purchase cost x 3/10,000

Where per hectare reaping time is estimated at 7 hours.

Scrap value: Purchase price x 5%
Depreciation: Purchase price - scrap value/service life
Capital interest: Purchase price/2 x 6%
Taxes: Purchase price/2 x 14/1000

Per liter cost of engine oil: 15 riels (Consumption: 4 liters per 100 service hours)

Per liter kerosene cost: 5 riels (Consumption: 3 liters per service hour)

Table #3: A. Reaping and threshing efficiency under the current system

| Variety / Plot | Area to be reaped | Milled and selected dry weight | Time (reaping and threshing) | No. of persons Hourly efficiency | Efficiency per area (reaping) |
|---|---|---|---|---|---|
| MEANG MENH TON (T1) | 450 m2<br>(1/2 KONG) | 130.49 KG | | | |
| NEANG MENH TON (T2) | 900 m2<br>(1 KONG) | 249.73 KG | 4 hrs. 25 min. Hand reaping<br>15 min. Tractor threshing | 2 56.5 KG/H<br>5 | 102m2/H -98H/HA<br>-H50'/KONG |
| IR5 (T3) | 900 m2<br>(1 KONG) | 305.83 KG | 7 hrs. 5 5 min. Hand reaping<br>42 min. Tractor threshing | 2 43.2 KG/H<br>5 | 635m2/H -150H15'/HA<br>-14H10'/KONG |
| IR5 (T4) | 900 m2<br>(1 KONG) | 352.5 KG | | | |
| B Combine reaping | | | | | |
| MEANG MANH TON | 2,700 m2<br>(3 KONG) | 800.4 KG | — | 490 KG/H | 1,653m2/H<br>-6H02'/HA<br>-0H32'/KONG |
| IR5 | 6,461 m2<br>(91 x 71) | 2,703.9 KG | - | 886.5 KG/H | 2,118m2/H<br>-4H43'/HA<br>-0H25'/KONG |

3) Observations

As far as combine efficiency up to this point goes, the highest level of efficiency attained so far in a field with optimally erect plants was 4 hrs/ha and the lowest, in a field of collapsed plants, was 13 hrs/ha. Where the standing angle of the plant is between 80x and 90x, cutting just the tops will be fine. However, in a field where the plants have collapsed and lie nearly flat on the ground, plants have to be cut at the root. When harvesting native species which have long culms, this adds a considerable burden to reaping operations. Needless to say, from the standpoint of combine reaping, the cultivation of varieties not prone to collapse is desirable. The average yield of native species cultivated in fields at the Center (but not in test plots) is 2.8 t/ha, while yields of approximately 4 t/ha are possible with an HYV such as IR-5. It should be noted that the size of these yields is also related to the reaping speed of the combine.

Under harvesting and rice plant foliage conditions in Japan, the combine can move through the field at a speed of 18 - 30 cm/sec. Observation of harvesting operations at the Center reveal that, regardless of the variety employed (native species or IR-5), plants with a standing angle of 75x - 90x do not exert much of a load on the combine and can be reaped at a speed of 40 - 50 cm/sec. In terms of cylinder speed (Table #1), whereas a speed of around 900 RPMs is employed in Japanese rice fields, a speed of 500 RPMs is quite sufficient in the Cambodian setting. In fact, when cylinder speed exceeds 600 RPMs, the number of broken kernels increases dramatically. Ironclad rules for combine adjustment are (1) to keep cylinder speed as low as possible and (2) to keep the cylinder concave gap wide, both of which are borne out by comparisons to Japanese rice. With respect to hid loss, having heard that native species were prone to shattering and that as much as 10% of the harvest is lost to natural falling of the grain, this subject merits further study. Since the divider on hand was unsuitable for this purpose, we had to invest a lot of time in the jury rigging of an improved one. Although we got the machinery into the best operating condition that we could and set out to conduct the survey, the jury rigged equipment did not function very well. Hid loss, the correlation of loss with the timing of reaping, differences among rice varieties and differences as a result of cultivation methods are all topics which need to be studied in future. As far as dividers are concerned, they are also in need of improvement. Although conditions were relatively good in the zones chosen for survey this year, when the paddy, for the most part directly sown and not subsequently weeded, was harvested, there was a high admixture of weed seeds. Weed infestation problems in a normal field will lower the harvested grain percentage and there will be a large number of empty husks which it is important to remove. However, even under current conditions, improved selection can be accomplished -- even where weed infestation is serious -- by mounting a screen in the upper section of the tank. In fact, such a screen was requested in an earlier report from the Center.

Machinery costs under the reaping conditions found in Cambodia are calculated in Table #2. With respect to taxes, capital interest and repair costs, since the Cambodian indices were incomprehensible, the Japanese index was applied. In the case of an item such as 'Repair costs', for instance, considering the cost of importing spare parts and the technical means required to manage and maintain machinery, real costs are probably considerably higher than those given. With respect to buildings (garaging), if we are thinking in terms of an extremely simple shack capable of protecting machinery from the rain, these costs depreciate yearly and, in bookkeeping terms, can be transferred to 'Building costs'.

The purchase price of a 10-foot combine is calculated in Japan (Nagasaki Prefecture ??Drought Countermeasures and Drainage Reclamation Department, Nagasaki Mechanization Study Center, 1970) at 5 million yen. Under normal conditions it can generally be utilized at a cost of 2500 yen/a and under ideal field conditions even more efficiently at approximately 1000 yen/a.

With wages in Cambodia at the 30 - 60 riel/day level, applying the time expenditures under the current system as noted in Table #3 and calculating an average yield of 1-t/ha and a rough rice price of 3 riels per kg, it becomes clear just how expensive machine costs are. However, the per hectare sums quoted in Table #2 change radically if the purchase price of the equipment is offset by grants in aid, as it is at the Center, amounting to 1/3, 1/2 or, in some cases, the entire purchase price. On the other hand, if we assume that a private party has purchased the equipment, has to pay wages during the harvest and wants to show some profit, the cost is going to be considerably higher than that quoted.

Barring extraordinary conditions, as the cost calculations and explanation above make clear, under the present conditions the widespread introduction of farm machinery in Cambodia is not economically feasible.

## II 1970 - 1971 Test Plan

## Cultivation Department

This test plan was proposed by local Cambodian personnel at the Center based on the instructions and policy of the Japanese technical staff. The prime objective of testing in this instance is to train the Cambodian personnel in the methodology and conduct of such testing. Any shortcomings in the present test plan aside, it is the first test plan formulated by the Cambodian personnel themselves and, from this standpoint, is highly significant.

### 1. Testing the quantity and timing of fertilizer applications

1) Objectives:

To clarify how the quantity and timing of fertilizer application in the cultivation of native species impacts wet rice growth and yield; to provide data for improving wet rice cultivation and technology in Cambodia.

2) Testing method:

Variety: Neang Menh Ton
Transplantation period: June
Seedlings: 30-day-old seedlings
Planting density: 16.6 clumps per square meter (30cm x 20cm);
3 seedlings per clump
Division of test plots: 25 square meter plots in sets of four

kg/ha

| Sample no. | Total quantity of fertilizer N,P,K | Base application N,P,K | 20 days after transplantation N,P,K | 10 days before spikelet formation N,P,K | Earing period N,P,K |
|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 |
| 2 | 30-30-30 | 30-30-30 | 0 | 0 | 0 |
| 3 | 30-30-30 | 0 | 0 | 30-30-30 | 0 |
| 4 | 60-60-60 | 30-30-30 | 0 | 0 | 30-30-30 |
| 5 | 90-90-90 | 30-30-30 | 30-30-30 | 0 | 30-30-30 |

Note: Mixed fertilizer in pellet form (15-15-15) was used.

3) Survey items:

Plant height, number of stems over time: 20 clumps
Growth period survey: Observations

Yield constituent analysis (culm length, ear length, number of ears, number of caryopsides, grain weight per ear, harvested grain percentage, 1000-grain weight): 20 clumps

Yield survey (total weight, straw weight, rough rice weight, rough rice to straw ration, per hectare yield): reaped from 3 square meter patches at two locations

## 2. Testing on planting density

1) Objectives:
In Cambodia, it's often the case that inferior seedling stock is transplanted in a random (low density) manner which results in a low number of ears and reduced yield. With this test we will attempt to clearly identify optimal planting density and thereby provide data for improving wet rice cultivation and technology in Cambodia.

2) Testing method

Variety: Neang Menh Ton
Transplantation: June
Planting density: From 11.1 to 33.3 clumps per square meter
Seedlings: 30-day-old seedlings with three seedlings per clump
Fertilizer: 60kg/ha each of N,P,K (half of which was applied as a supplemental application)
Division of test plots: 25 square meter plots in sets of four.

| Sample no. | Planting density |
|---|---|
| 1 | 33.3 clumps/m² (30cm x 10cm) |
| 2 | 26.6 (25 x 15 ) |
| 3 | 16.6 (30 x 20 ) |
| 4 | 11.1 (30 x 30 ) |

3) Survey items: Same as those for Test I.

## 3. Testing on the timing of transplantation

1) Objectives:
Because wet rice cultivation in Cambodia relies on natural rainfall, the timing of seedling transplantation may vary considerably from year to year. Consequently, testing in this instance will attempt to identify the impact of varying transplantation dates on the growth and yield of wet rice, thereby providing data for the improvement of wet rice cultivation and technology.

2) Testing method

Variety: Neang Menh Ton
Transplantation period: June 10 - August 10
Planting density: 16.6 clumps per square meter (30cm x 20cm); 3 seedlings per clump
Quantity of fertilizer: Base application of 30kg/ha each of N,P,K
Division of test plots: 25 square meter plots in sets of four

| Sample no. | Transplantation date |
|---|---|
| 1 | June 10 |
| 2 | June 30 |
| 3 | July 20 |
| 4 | August 10 |

3) Survey items: Same as those for Test I.

4. Testing to determine the impact of seedling age (number of days in the seedling bed) on wet rice growth and yield

1) Objctives:
In Cambodia, the wet rice cannot be transplanted to the paddy until the rains come. Where planting is delayed, seedlings may be left for a rather long time in the seedling bed, a situation which results in aged (inferior) seedlings. This test will attempt to identify how the age of seedlings (the number of days in the seedling bed) impacts wet rice growth and yield, thereby providing data for the improvement of wet rice cultivation and technology.

2) Testing method

Varieties: Masuri and Neang Menh Ton
Transplantation period: June
Planting density: 16.6 clumps per squa~~re~~ meter; 3 seedlings per clump
Seedlings: From 15- to 55-day-old seedlings
Fertilizer: 60 kg/ha each of N,P,K (half of which was applied as a supplemental application)
Division of test plot: 25 square meter plots in sets of four

| Variety | Masuri | N.M.Ton. |
|---|---|---|
| Seedling age (no. of days)<br>Sample no. | | |
| 1 | 15 days | 25 days |
| 2 | 25 days | 35 days |
| 3 | 35 days | 45 days |
| 4 | 45 days | 55 days |

3) Survey items: Same as those for Test I.

5. Testing the flood resistance of Indica varieties

1) Objectives:
The rainy season crop in Cambodia is often subjected to flooding

conditions after planting. Flooding can kill the rice plant or drastically diminish its growth potential. Farmers may deal with this situation by additional planting, replanting or simply abandoning the crop. Testing in this instance will examine the relationship between the growth stage of the wet rice and flooding resistance and then attempt to identify appropriate methods for dealing with damaged wet rice.

2) Testing method

Sites: Muddy river and clear pond
Variety: Kong Khsach
Materials: 162 1/50,000 pots

Sowing:
Direct sowing was done in pots starting at the end of May. Five seed grains per pot.

Division of test plot:
As shown in the table below. Samples placed in the muddy river and clear pond were treated identically in single sets. Standard water depth was 3cm. Following processing, water depth was maintained at 3cm for all samples. The number of days of processing were 3, 5, 7 and 10 days, respectively for each test lot.

| water depth / Plant height | 3cm (standard) | 5cm | 10cm | 20cm | 30cm | 40cm | 50cm | 60cm |
|---|---|---|---|---|---|---|---|---|
| 5 cm | o | o | o | o | | | | |
| 10 cm | o | o | o | o | o | | | |
| 20 cm | o | | o | o | o | o | | |
| 30 cm | o | | | o | o | o | o | |
| 40 cm | o | | | | o | o | o | o |

3) Survey items: Rapid growth, leaf age, and number of offshoots directly before and after processing.

Survey plant height, leaf age, number of offshoots and quantity of dry matter.

6. For use in exhibitions of cultivation with fertilizers

| | |
|---|---|
| Neang Menh Ton | 0.5ha |
| IR-5 | 0.5ha |

## Soil and Fertilizer Department

### 1. Testing to determine the quantity and timing of nitrogenous fertilizer application in wet rice cultivation (continuation)

1) Objectives:
To determine the optimal application methodology for nitrogenous fertilizer in the cultivation of native species and under varying soil conditions

2) Testing period: 3 years

3) Test plan

4m x 6m test plots in sets of four

Fertilizer: Nitrogenous fertilizer applied is urea and the phosphatic fertilizer is domestically produced in Tuk Meas.

Field division: The fertilizer application plan for each test plot is as follows:

1. N1,P1 - Applied prior to transplantation
2. N1/2, P1 - Applied prior to transplantation
   N1/2 - Applied 30 days prior to earing (2 months after transplantation)
3. N1/2, P1 - Applied prior to transplantation
   N1/2 - Applied before earing
4. N1/3, P1 - Applied prior to transplantation
   N2/3 - Applied at the start of earing
5. N1/3, P1 - Applied prior to transplantation
   N1/3 - Applied at the start of offshoot growth
   N1/3 - Applied at the start of earing
6. - Without fertilizer

Varieties
- A. Kong Khsach
- B. Neang Menh
- C. Srauv Koul
- D. Chhuthana

Test sites (7 locations)
- * Prey Veng
- * Kauk Trap (both at sandy and alumy soil sites)
- * Prek Thnot
- * Slakou (Takeo)
- * Kauk Patry
- * Banan
- * Tuol Samrong (the Center)

Method of cultivation
Tilling methods and timing of sowing in accordance with local practices.

Transplantation: Done when seedlings had developed 5 - 6 leaves.
Plant distance: 20cm x 20cm; 3 seedlings per clump

## 2. Testing to determine the economic viability of the Neang Menh variety (continuation)

1) Objectives:

- Examine the correlation between the amounts of nitrogenous fertilizer applied and productivity
- Examine actual fertilizer utilization efficiency

2) Test plan

Location: C.T.A. (Agricultural Center)
Soil type: Brown hydromorphics
Variety: Neang Menh

Sowing
Seed quantity: 100g per square meter
Fertilizer: N 0.5kg, P205 1.5kg, K20 1.5kg per a

Transplantation
Transplantation period: Seedlings have developed 5 - 6 leaves
Planting distance: 15 x 25cm; 3 seedlings per clump
Otherwise in accordance with regular practices.

Plot division plan is as follows:

| | N | $P_2O_5$ | $K_2O$ |
|---|---|---|---|
| 1. — No fertilizer | 0 — | 0 — | 0 |
| 2. — N1P2 | 30 — | 60 — | 0 |
| 3. — N2P2 | 60 — | 60 — | 0 |
| 4. — N3P2 | 90 — | 60 — | 0 |
| 5. — N4P2 | 120 — | 60 — | 0 |
| 6. — N5P2 | 150 — | 60 — | 0 |

The quantities of nitrogenous fertilizer applied in each application are as shown below:

| Sample no. | Prior to transplantation | During the offshoot growth period | During the earing period |
|---|---|---|---|
| 1 | 0 | 0 | 0 |
| 2 | 10 | 10 | 10 |
| 3 | 30 | 15 | 15 |
| 4 | 50 | 20 | 20 |
| 5 | 60 | 40 | 20 |
| 6 | 80 | 50 | 20 |

Note: The nitrogenous fertilizer employed is urea. The phosphatic fertilizer is domestically produced Tuk Meas Hyperphosphate.

(Otherwise, test plot division, observation items and survey items are all identical to the test conducted in 1969.)

3. A soil profile survey of the nation's representative paddy soils and an examination of their productivity

1) Objectives:

A soil profile survey of the nation's representative soils was conducted in 1962 with U.S. cooperation. This particular survey, however, will limit itself to paddy soils and focus on productivity. By pursuing the correlation between soil and productivity, this survey can serve as resource in the conduct of future rice cultivation.

2) Survey location

| | | |
|---|---|---|
| (1) | Tuol Samrong (Agricultural Center) | Brown Hydromorphics |
| (2) | Siem Reap | Cultural Hydromorphics |
| (3) | Sisophon | Plinthite Podzols |
| (4) | Kompong Cham | Lacstrine Alluvial Soils |
| (5) | Takeo | Cultural Hydromorphics (NaCl) |
| (6) | Kompong Speu | Red Yellow Podzols |

These soil characterizations are based on Crocker.

3) Soil profile

A one meter deep soil sample was bored and the physical properties, color and chemical composition of the various strata in the sample examined.

4) Pot test

Soils collected from various locations were placed in 1/20,000 Wagner's pots and cultivation conducted under uniform conditions in all of them. The Samples for this test were organized as follows:

Pots were cultivated in sets of two

| Sample no. | | P205 | K20 (per ha) |
|---|---|---|---|
| 1 | 0 | 0 | 0 |
| 2 | 0 | 60 | 0 |
| 3 | 60 | 60 | 15 |
| 4 | 60 | 60 | 20 |
| 5 | 60 | 60 | 30 + CaSiO2 2 tons |

Note: Nitrogenous fertilizer employed is urea, phosphatic fertilizer is Tuk Meas Hydrophosphate, and potassic fertilizer is potassium chloride.

5) Variety: Kong Khsach; each pot receiving two transplanted clumps.

6) Test period: May through December, 1970

7) Survey and observation items:

- Inquire locally about the environment at each survey site, methods of cultivation commonly employed, yield and water use conditions.
- Growth survey: Offshoot growth period, spikelet formation period, ripening period, plant morphology, etc.
- Yield survey
- Soil analysis: PH, nitrogen, phosphate, potassium, etc. measured before and after the test.
- Plant morphological analysis: Constituent analysis of harvested rough rice and straw

Below is a summary of the survey and analyses conducted at the locations cited above which have been completed.

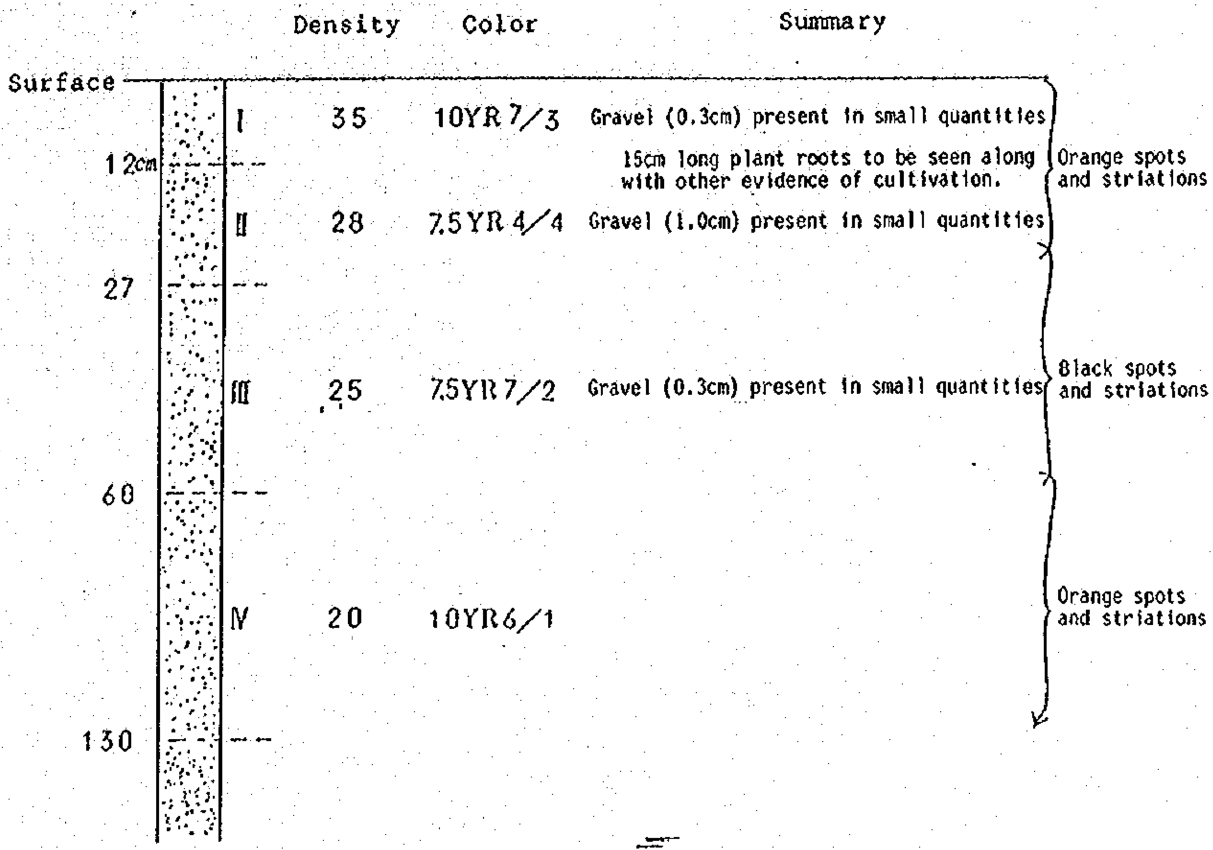
8) Survey results from the various test sites

(1) Tuol Samrong (Agricultural Center); Survey of March 3
Location: A field at the Center

The principal physical characteristics derived from the soil profile are as follows:

Soil character: clayey

Note: Soil density was measured with a Yamanaka-type hardness meter and soil color was characterized according to the Soil Color Index (issued by the Japanese Ministry of Agriculture and Forestry). These same controls were applied to all samples.



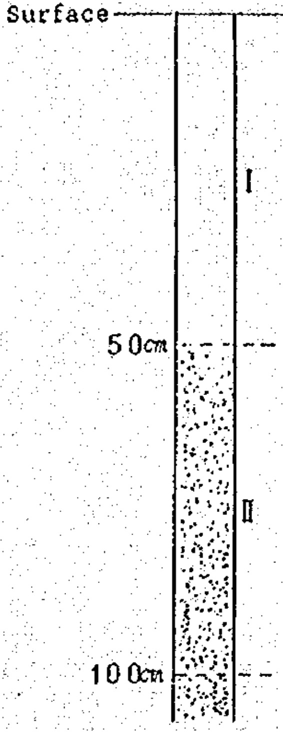
It should be remembered that soil moisture content, which increases as one goes deeper, will impact density measurements. (This holds true for all tests below.)

(2) Siem Reap survey conducted on February 28, 1970

Location:
The village of Srangher in the District and Province of Siem Reap

Environmental conditions:
A typical section of paddy belonging to a family farm in the neighborhood of the Kauk Patry Test Station was chosen.

Although the abundant irrigation waters of Barai Occidental are nearby, the highlands where this site is located do not have access to its waters. Average yield in the area is 0.5 - 0.7 t/ha with an average paddy size of 20 - 50a. Cultivation is by seedling transplantation and the preferred rice variety is Krachak Chap. The soil is sandy.

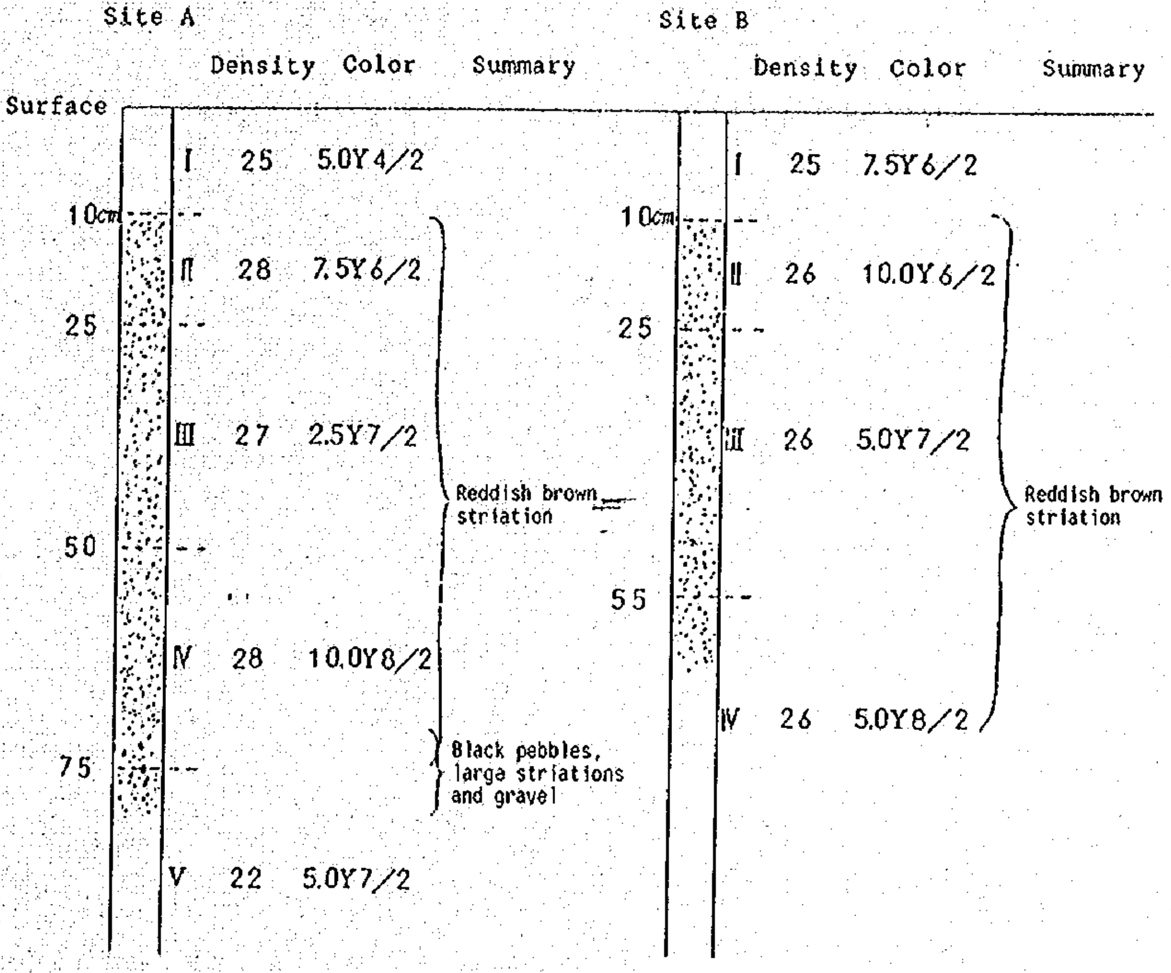


| | Density | Color | Summary |
|---|---|---|---|
| I | 25 | 7.5YR8/4 | |
| II | 21 | 7.5YR8/6 | Black and orange spots and striations are observed below 50cm. The soil remains sandy even at depths greater than 1m. |

### (3) Sisophon

**Location:**
Samrong village in the Sisophon District of Battambang Province

**Environmental conditions:**
The railway line runs from Sisophon towards the Thai border. The international frontier is 32km away, at Poipet. The area is surrounded by wilderness. Water resources are very poor and farmers are completely dependent on rainfall. The potentially arable area here is actually quite large. Character of the soil: clayey.

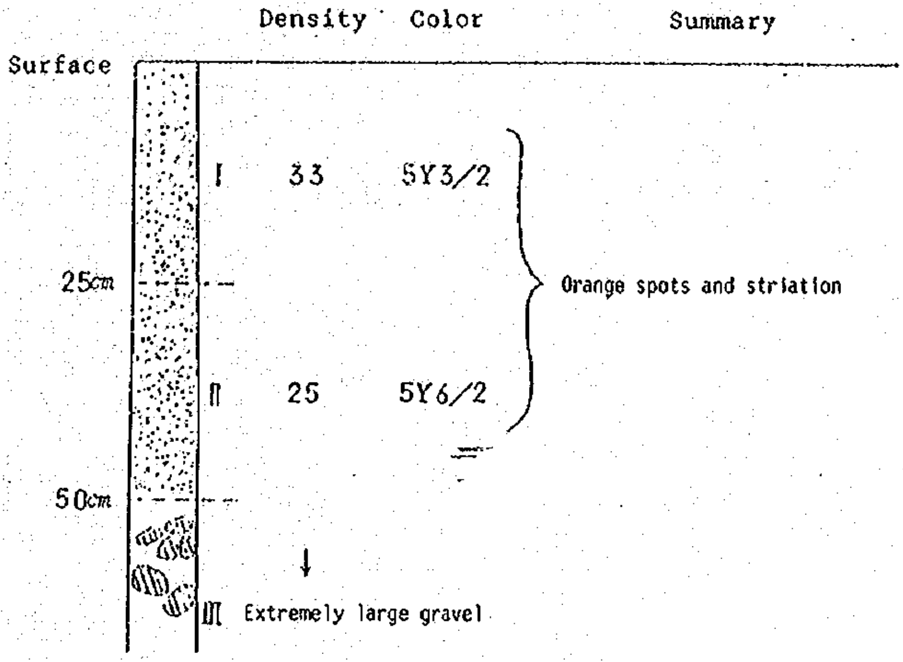


In both samples, top soil is thin with grey or brown glei strata at depths below 1m. It is a heavy clayey soil with low humus content.

### (4) Kompong Cham

Location:
Chamcar Svay village in the Chamcar Leu District in Kompong Cham Province

Environmental conditions:
Paddy size in this area is quite small, averaging between 3.0 - 4.0a. Plowing is done with animal power. Paddy soil is hard with extremely high cohesive strength. Small-scale irrigation facilities are available and water storage is possible. Seedling transplantation is practiced and average yield is 2.0 - 2.55 t/ha.

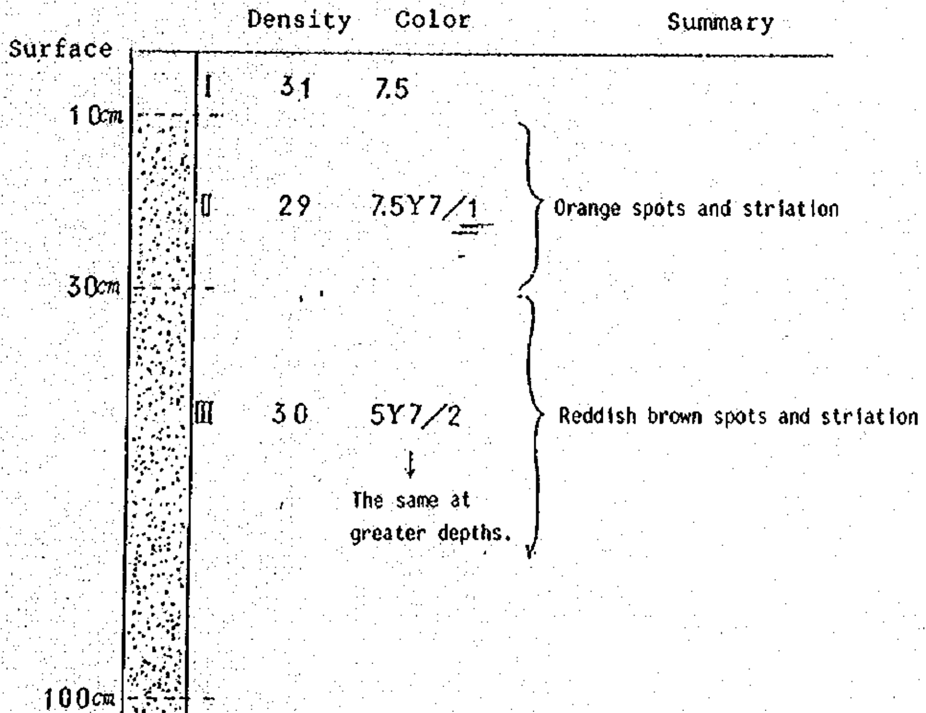


(5) Takeo

Location:
Pich Sar village, Koh Andeth District of Takeo Province

Environmental conditions:
This site is located on the road between Phnom Penh and Phnom Den on the Vietnamese border. Average paddy size is 10a and seedling transplantation is practiced. The area is famous for the salt damage done to the land. The cause is unclear although it is theorized that ocean water may be backflowing through waterways or seeping into ground water and then percolating up. This year, paddy which had been planted but not harvested was to be seen. Local farmers informed us that average yields were a very low 0.4 - 0.7 t/ha. Flood waters in this region generally reach a height of 0.5 - 1.0m but may go even higher.

Since some of the lands near Takeo City can be irrigated, a directly sown dry season crop is planted in late November and harvested in early March. Yield is reported at 1.5 - 2.0 t/ha.



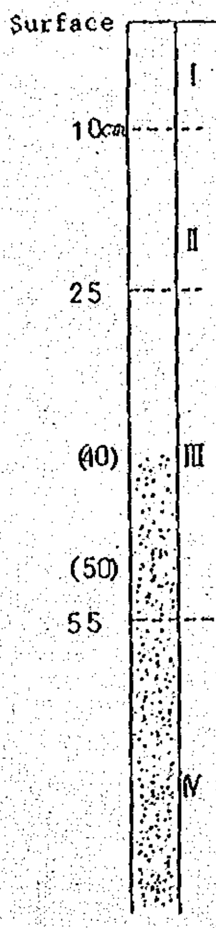
Although this soil is characterized as sandy it also has some clay content.

(6) Kompong Speu   Survey conducted on February 14, 1970

Location:
Preach Nypean village in the Kong Pysey District of Kompong Speu Province

Environmental conditions:
This test site is located on National Highway #3 near the Kandal provincial border. According to local farmers, lack of water rather than flooding is the problem in this region. Flood waters average 50cm in depth. Average yield is 0.7 t/ha and cultivation is done by seedling transplantation. The major varieties cultivated are Tong Malou and Neang Menh

Soil character:
Surface is sandy and the lower depths are extremely clayey.



| | Density | Color | Summary |
|---|---|---|---|
| I | 28 | 7.5YR7/3 | |
| II | 28 | 7.5YR5/8 | Sandy soil with some clay content. |
| III | 21 | 7.5Y6/6 | Clayey character with black concretions |
| IV | 24 | 7.5Y6/8 | Reddish brown with black concretions |

(7) A summary of the physical characteristics of the various soils examined in the surveys listed above:

| Survey location / Item | | Tuol Samong | Siem Reap | Sisphone | | Kg.Cham | Takeo | Kg. Speu |
|---|---|---|---|---|---|---|---|---|
| | | | | A | B | | | |
| Soil strata boundaries | | Clear | " | " | " | " | " | " |
| Form of soil strata boundaries | | Flat - irregular | " | " | " | " | " | " |
| Humus content | | Non | " | " | " | " | " | " |
| Stria-tions - concre tions | ① Color | 0-12cm (Slightly orange)<br>12-27 cm Upper section orange and lower section orange and black<br>27-60 Black<br>60- Orange | 50- Orange and black | 10-80 Reddish brown<br>60-80 Black pebbles | 10-80 Reddish brown | 0-50 (all strata) Orange | 10-30 Orange<br>30- Reddish brown | 40-55 Black<br>55- Reddish brown |
| | ② Hardness | Soft concretions | " | " | " | " | " | " |
| | ③ Morphology | Spots and veins | " | " | " | " | " | " |
| Plasticity | | I Stratum High (very high)<br>II High (very high)<br>III High (very high)<br>IV High (very high) | I 0<br>II 0 | I High (very high)<br>II High (very high)<br>III High (very high)<br>IV High (very high) | "<br>"<br>"<br>" | I 0<br>II Low | I 0<br>II 0<br>III High | I 0<br>II 0<br>III 0<br>IV High |
| Adhesive properties | | I Strong<br>II Strong<br>III Strong<br>IV Strong | I 0<br>II 0 | I Strong<br>II Strong<br>III Strong<br>IV Strong | "<br>"<br>"<br>" | I Moderate - Strong<br>II Moderate - Strong | I 0<br>II 0<br>III Strong | |
| Gravel | | I-III Less than 5% fine gravel<br>IV None<br>I Dry | I Dry - semi-dry | Minute amounts fine gravel<br>I Dry | "<br>" | I Fine - small<br>II lower section Large and very large fine gravel<br>I Dry | I Dry | I-II Minute amounts of fine gravel<br>I Dry |
| Moisture content (at time of survey) | | II Semi-dry<br>III Semi-dry<br>IV Semi-dry - Moist | II Semi-dry | II Dry<br>III Semi-dry<br>IV Semi-dry - Moist | "<br>"<br>" | II Semi-dry | II Semi-dry<br>III Semi-dry | II Dry<br>III Semi-dry<br>IV Semi dry |

(8) PH and effective phosphate levels as obtained during the present round of soil analyses

| Item<br>Location and soil depth | | | PH | | Effective phosphate residue mg/100g | Nitrogen | Potassium |
|---|---|---|---|---|---|---|---|
| | | | H2O | KCl | | | |
| Tuol Samrong | | cm<br>0~12 | 5.0 | 3.4 | 0.5 | | |
| | | 12~27 | 5.0 | 3.4 | 0.13 | | |
| | | 27~60 | 5.3 | 3.4 | 0.13 | | |
| | | 60~ | 5.1 | 3.7 | 1.5 | | |
| Siem Reap | | 0~50 | 5.0 | 3.7 | 0.5 | | |
| Sisophone | A | 0~10 | 6.2 | 4.4 | trace | | |
| | | 10~25 | 6.3 | 4.3 | trace | | |
| | | 25~50 | 6.6 | 4.3 | trace | | |
| | | 50~70 | 6.0 | 4.3 | trace | | |
| | B | ~10 | 5.8 | 4.5 | trace | | |
| | | 10~25 | 5.9 | 4.5 | trace | | |
| | | 25~55 | 6.5 | 4.9 | trace | | |
| Kg. Cham | | 0~25 | 6.7 | 5.2 | 0.13 | | |
| | | 25~50 | 7.8 | 5.5 | 0.5 | | |
| Takeo | | 0~10 | 4.4 | 3.7 | 0.13 | | |
| | | 10~30 | 4.5 | 3.4 | 0.13 | | |
| | | 30~ | 4.9 | 3.4 | trace | | |
| Kg. Speu | | 0~10 | 6.6 | 4.3 | 0.13 | | |
| | | 10~25 | 8.1 | 5.7 | 0.13 | | |
| | | 25~55 | 8.5 | 5.6 | 0.13 | | |
| | | 55~ | 8.5 | 5.8 | 0.13 | | |

* Due to the outbreak of war, it was not possible, regrettably, to gather data on nitrogen and potassium content.

* As expected phosphate content was extremely low.

* Some of the paddy in Kompong Speu Province tends to be alkali.

## 4. Preparatory testing of rice cultivation in wilderness areas

### 1) Objectives:

Cambodia still has rather large tracts of wilderness. In many cases these are areas which were once cultivated but were abandoned because of lack of water resources and/or poor soil. Assuming that water control is possible in some areas and the use of fertilizers to enhance soil fertility, some of these areas could be cultivated to improve the economic lot of local farmers. With respect to the feasibility (from a management point of view, as well) of cultivation in these wilderness areas, preparatory testing focusing primarily on the application of fertilizers was implemented.

### 2) Test plan

Location:
Srok Sisophon (a site about 32km from Poipet mentioned above in 3.(3))

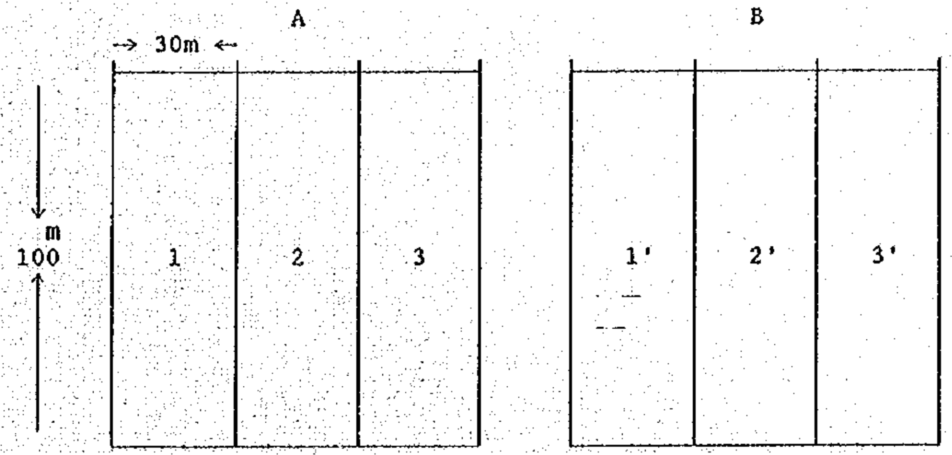
Testing period: May through December, 1970
Cultivated area: 180a (plots in pairs with each block 30a)
Fe rtilizer: Nitrogenous fertilizer is urea and phosphate is Tuk Meas Hyperphosphate
Variety and method of cultivation: Native species, direct sowing of 8kg/10a of seed (as normally practiced)

Plot division:

| | Total amount | | | Base application | | | Supplemental application | | |
|---|---|---|---|---|---|---|---|---|---|
| | Nitrogen | Phosphate | Potassium | Nitrogen | Phosphate | Potassium | Nitrogen | Phosphate | Potassium |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 45 | 60 | 0 | 30 | 60 | 0 | 15 | 0 | 0 |
| 3 | 90 | 60 | 0 | 60 | 60 | 0 | 30 | 0 | 0 |

Supplemental application was applied during the earing period.

Test plot division:



Survey and observation items:

- Growth survey: tillering, plant height (tillering period, spikelet formation period, maturation period)
- Yield survey
- Chemical analysis, bronzing survey
- Labor requirements and management cost survey

5. Productivity and changes in soil properties as a result of cultivation with large-scale machinery

1) Objectives:
For some years now, tractors have been in used to till fields at the Center and, on a sub-contracted wage basis, to till the paddy of local family farms. Since machine cultivation can be expected to impede soil water permeability and impact rice growth, the purpose of this survey is to examine any physical changes in the soil caused by the use of tractors and to identify the impact, if any, of machine cultivation on wet rice growth.

2) Test plan

Location: Fields at the Center
Variety: Neang Menh
Time period: April through December, 1970 (scheduled to continue beyond this time frame)

In terms of method of cultivation and fertilizer utilization, normal planting practices at the Center were followed.

Description of survey

(1) Determine through a soil profile whether or not the plowed soil strata have been impacted, measure hardness and analyze the physical properties of the soil

(2) Deep tilling with the tractor: 30cm

(3) Growth survey of various patches of wet rice
Tillering, plant height and weed growth at different periods of plant development

(4) Yield survey

(5) Survey of soil physical properties after harvesting as described in (1) above

Test plots
(This test to be conducted simultaneously with the following one.) See "6." below.

## 6. The correlation between changes in the soil as a result of returning rice stubble to the field and rice productivity

1) Objectives:

Although Cambodian rice farmers customarily burn the rice stubble, raking the stubble back into the field is considered a means of improving the soil. This test will examine the impact of this technique on the physical properties of the soil, rice productivity and the occurence of plant diseases and harmful insects.

2) Test plan

Same as "5." above.

3) Survey description

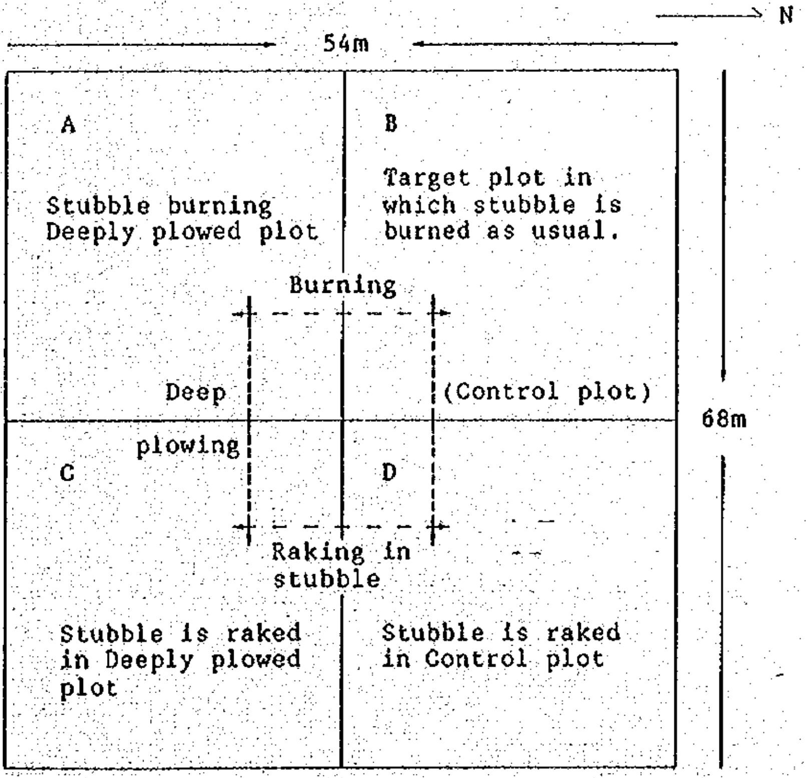
Same as "5." above.

The results of measuring soil hardness at varying depths on April 24, 1970 are listed below.

| Depth (cm) | 0 | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Density | 34 | 34 | 32 | 34 | 30 | 30 | 29 | 29 | 30 | 29 | 30 | 30 | 30 | 30 | 30 |

Density was measured with a Yamanaka-type hardness meter.

4) Layout of test plots (Tests 5. and 6. implemented jointly.)



# Agricultural Machinery Department

## 1. Survey of large-scale mechanization and current systems of cultivation

### 1) Objectives

Based on a request from the Agricultural Affairs Agency, farming operations (tilling, harrowing, sowing and harvesting) were performed with large-scale equipment and the necessary attachments. In addition to collecting data which might contribute to improved operational techniques, an attempt will also be made to create suitable indices to aid in cost calculations for agricultural machinery utilization in Cambodia. This will, of course, require that additional cost calculations on operational efficiency, yearly operating time, service life, scrap value, repair costs, etc. be collected from other Centers and Test Stations. Once these data are in hand, we can compare mechanized agriculture to the current system of cultivation and also consider how agricultural tools in the current system might be improved.

### 2) Machinery and equipment to be used

Tractor (large-scale 500HP), bulldozer
Bottom plow 14" x 2, 18" x 1
Disc plow 26" x 3, 30" x 5
Disc harrow, tandem-type, category 2
Spiketooth harrow
Fertilizer applicator/sower
Drill seeder
Broadcaster
Combine
Farm tools currently in use with stock animals (oxen and water buffalo)

Survey location:
The Khmer-Japanese Friendship Agricultural Technical Center in Battambang Province, Cambodia

## 2. Test to compare row and random sowing (test continuation)

* Due to the flooding and weed problems encountered in last year's testing, different fields were selected for this year's.

Variety: Neang Smoeur
Quantity of seed sown: 80kg/ha
Area: 15ha
Fertilizer applied:
  1) N,1 P,1 K,0 (N,30kg P,30kg and K,0kg/ha)
  2) N,1 P,2 K,0 (N,30kg P,60kg and K,0kg/ha)

Base application

| A | B | C | D |
|---|---|---|---|
| N1P1 | N1P1 | N1P2 | N1P2 |
| Row sowing | Random sowing | Row sowing | Random sowing |
| Space between rows: 21cm | | Space between rows: 21cm | |

Tool for random sowing: Broadcaster
Tool for row sowing: Drill seeder

Weed prevention:
Nothing done in Plots A and B. CPA applied in Plots C and D.

Plant disease and harmful insects: In accordance with regular practices, no countermeasures initiated.

Irrigation: As regularly practiced

Survey items:
- Plant height
- Number of offshoots (Number of stems per square meter)
- Yield: (Total yield per unit of area)

3. Testing the effects of raking stubble back into the fields

Objectives:
Based on a joint plan developed with the Soil and Fertilizer Department (Tests 5 and 6), survey the effects of raking stubble back into the field and the impact of deep plowing on wet rice growth and yield.

Test plow:

| | |
|---|---|
| Bottom plow | 14" x 2 |
| Bottom plow | 18" x 1 |
| Disc plow | 26" x 3 |

4. Surveys on combine reaping and its cost efficiency (continuation of tests from the previous year)

1) Survey the amount of fallen grain after reaping, hid loss and other forms of grain loss and damage in both native species and introduced varieties.

2) Reaping conditions and a equipment cost calculation

## Plant Breeding Department

1. Selection

| | |
|---|---|
| a) Varieties introduced by the plant breeding test stations | 50 varieties |
| b) Hybrids derived from native species | 20 varieties |
| c) Hybrids derived by crossing native species with introduced varieties | 20 varieties |

2. Yield comparison test

a) Fixed native varieties 30 varieties

b) Varieties which are not photo-period sensitive 56 varieties

3. Test comparing methods for the cultivation of superior varieties

Employ five previously selected superior native species

a) Direct sowing b) Direct sowing and mid-term shallow plowing c) Row sowing d) Seedling transplantation

How do these different methods of cultivation impact plant growth and yield?

4. Plant responsiveness to nitrogenous fertilizer

Employ four previously selected superior native species and apply varying amounts of nitrogenous fertilizer (from 30 - 150kg/ha)

5. Increased cultivation of seed stock

Row sow 40are each of 10 superior native species.

6. Row sowing in large-scale cultivation

Cultivation of 15ha of the Snguon Thang variety

## Phytopathology Department

1. Test the blast resistance of the principal native species and introduced varieltes

Native species: 10 varieties Introduced species: 10 varieties

2. Testing to prevent blast in the seedbeds

Variety: Kong Khsach, IR-5

Chemical agents employed: Bla-S, Bla-SM, Bordeaux composite agent

3. Testing to prevent sheath rot caused by Acrocylindrium oryzae

Varieties and agents same as "2."

4. Survey the way the principal rice plant diseases get started

   Fields at the Center

5. Survey plant diseases of other crops

   Gather samples, take photographs, isolate and culture pathogens

6. Research the prevention of sheath blight with chemical agents

   Varieties: Neang Menh Ton, Kong Khsach
   Chemical agent: "Mon-nyu zai" emulsion

## Entomology Department

1. The relationship between the effectiveness of Gamma-BHC pellets to combat stem borers and water depth

   Variety: IR-5
   Water depth: 2cm, 10cm Pot test

2. Dry field crops

   Sugarcane
   1. Research what amounts of fertilizer are optimal for sugarcane cultivation
   2. Survey varietal characteristics and select superior varieties

   Vegetables
   1. Onions: Correlation between sowing time and growth/yield
   2. Garlic: Correlation between sowing time and growth/yield
   3. Test fertilizers in garlic cultivation
   4. Identify the optimal soil PH for garlic

   Others