REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS AND ELECTRIC POWER
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

FEASIBILITY REPORT ON THE WONOGIRI IRRIGATION AND UPPER SALA RIVER IMPROVEMENT PROJECT

APPENDIX III AGRICULTURE, INSTITUTIONS AND PROJECT ECONOMY

JAPAN INTERNATIONAL COOPERATION AGENCY

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1. AGRICULTURE

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1. NATIONAL AND REGIONAL ECONOMY

1.1 POPULATION

Indonesia had the population of about 123.1 million in 1972 with the population density of 59 per km^2. Total population in Central Java is estimated at about 22.5 million and the population density per km^2 was around 700 in 1972. The population growth rate has been 1.7% per year during the past decade, which is relatively lower compared with that of 2.1% of all Indonesia.

According to the forecast made by the Central Bureau of Statistics, the population is expected to increase by 1.9% per annum and will attain to 26.1 million in 1980 in Central Java, while relatively high growth rate of 2.3% per annum is anticipated for whole Indonesia.

With respect to the population structure, more than 60% of the working population is now engaged in agricultural sector followed by service sectors such as trade and community service, while only 10% of the population is in manufacturing sector. As shown in Table I-3, the population structure of Central Java is almost the same as that of all Indonesia and agricultural sector seems to play an important role in terms of employment.

Table I-1 Present Population and Forecast

(1,000)

	1971	1972	1973	1974	1975	1980
Central Java	22,022	22,466	22,905	23,340	23,776	26,052
Indonesia	120,149	123,115	126,088	129,083	132,110	148,349

Source: Social Indicators 1974
Note : 71 - 72 Census data and estimated
73 - 80 Forecast

Table I-2 Annual Population Growth Rate and Density

	1930 - 1961	1961 - 1971	Pop. Density
Central Java	1.0%	1.7%	634/km^2
Indonesia	1.5%	2.1%	59/km^2

Source: Social Indicators 1974

Table I-3 Population by Occupation (1971)

(%)

	Central Java	Indonesia
Agriculture	62.8	64.2
Mining	0.1	2.1
Manufacturing	10.1	6.5
Electricity, Gas and Water	0.1	0.1
Construction	1.5	1.6
Trade, Restaurant and Hotels	12.4	10.3
Transport, Storage and Communication	1.6	2.3
Finance and Insurance	0.1	0.2
Community Service	9.4	10.0
Others	1.9	2.7
Total	100.0	100.0

Source: Social Indicators 1974

1.2 ECONOMIC STRUCTURE

1.2.1 Gross Domestic Product (GDP)

As in the case of most of the South East Asian countries, economy of Indonesia depends on the primary sector, particularly the agricultural sector. In 1973, the primary sector such as the agricultural sector produced about 13%, while the remaining 38% was raised by the third sector such as trade, finance and other services. Gross Domestic Product in 1971 was estimated at R_p. 31.6 thousand (US$76).

As for economic growth, Indonesia has attained satisfactory level of growth rate. During the past five years from 1968 to 1972, GDP is estimated to have increased by 7.8% per annum, which was rather high compared with that of 2.1% per annum from 1965 to 1967.

The economic structure of Central Java is similar to that of whole Indonesia. Summary of the regional economy of Central Java is presented in Table I-5 in comparison with that of whole Indonesia. As shown in the comparative table, agricultural sector produced about half of the total product in Central Java followed by service sector such as wholesale and trade sector and manufacturing sector. In agricultural sector, about 80% of the product was raised by farm food crops.

Regional Domestic Product in Central Java was R_p. 487 billion (US$1.17 billion) and per-capita GDP was R_p. 22.1 thousand (US$53) in 1971.

With respect to the relation to national economy, manufacturing sector contributed relatively well to GDP compared with such sectors as construction, transportation and communication, banking and finance, and services, which are comparatively minor sector in the national economy.

In total, Central Java contributed to national economy by producing about 13% of the national product.

Table I-4 GDP in Indonesia

(Rp. 10^9)

	1971	1972	1973/1	%
Agriculture, Forestry & Fishery	1,655	1,825	2,628	39.8
Farm food crops	(962)	(1,071)	(1,550)	
Non-farm food crops	(206)	(213)	(322)	
Estate crops	(105)	(119)	(155)	
Animal husbandry	(124)	(135)	(175)	
Forestry & hunting	(142)	(173)	(291)	
Fishing	(116)	(114)	(135)	
Mining & Quarrying	249	386	617	9.3
Manufacturing	356	417	571	8.7
Electricity, Gas & Water Supply	18	20	30	0.5
Construction	128	174	262	4.0
Wholesale & Retail Trade	712	912	1,350	20.4
Transportation & Communication	162	182	261	4.0
Banking & Other Financial Intermediaries	45	53	82	1.2
Ownership of Dwelling	74	92	134	2.0
Public Administration & Defence	214	290	405	6.1
Services	181	197	265	4.0
Gross Domestic Product	3,794	4,548	6,605	

Note: /1 Preliminary figure

Source: Indikator Ekonomi Nov. 1975

Table I-5 Gross Regional Product of Central Java and GDP in 1971

	(A) Central Java		(B) Indonesia		(C) Share of Central Java (%) (A)/(B)
	Amount (10^9 Rp.)	(%)	Amount (10^9 Rp.)	(%)	
Agriculture & Forestry	236	(48.4)	1,655	(43.6)	14.3
a) Farm food crops	(183)		(962)		
b) Non-Food crops	(20)		(206)		
c) Estate crops	(15)		(105)		
d) Animal husbandry	(11)		(124)		
e) Forestry & Housing	(4)		(142)		
f) Fishing	(3)		(116)		
Mining & Quarrying	3	(0.6)	249	(6.6)	1.2
Manufacturing	62	(12.7)	356	(9.4)	17.4
Construction	8	(1.7)	128	(3.4)	6.3
Electricity, Gas & Water Supply	2	(0.4)	18	(0.5)	11.1
Transportation & Communication	11	(2.2)	162	(4.3)	6.8
Wholesale & Retail Trade	104	(21.3)	712	(18.8)	14.6
Banking & Finance	4	(0.9)	45	(1.2)	8.9
Ownership of Dwelling	23	(4.8)	74	(2.0)	31.1
Public Administration	22	(4.5)	214	(5.5)	10.3
Services	12	(2.5)	181	(4.7)	6.6
Total	487	(100.0)	3,794	(100.0)	12.8
Per-capita GDP (10^3 Rp)	22.1		31.6		

Source: Regional Income from Several Provinces in Indonesia 1974
Economic Indicators 1974

1.2.2 Agriculture

As mentioned above, agriculture is the dominant sector of the Indonesian economy. It accounts for about 40% of the Gross Domestic Product (GDP), and provides employment for about 60% of the labor force. In the agricultural sector, food crop production is by far the most important component, which amounts to about 60% of the total agricultural products. Agriculture sector, as a whole, made a stable growth of 4% per annum during 1969 to 1973.

As a main food crop, rice production increased by 4.7% per

annum during the period of 1968 - 1974 and amounted to about 15,450 thousand tons in 1974. Production of other staple food crops such as maize and cassava did not make significant growth and stagnated at the previous low level. On the contrary, production of cash crops like soybean and estate crop such as sugar increased at a relatively steady growth rate of 4.6% and 6.3%, respectively during that period. Total productions of soybean and sugar were 550 thousand tons and 1,025 thousand tons in 1974, respectively.

The stable production increase of rice attained in this period is attributable partly to unit production increase, which corresponds to the progress of rehabilitation work of the existing irrigation system and increased input dosage, and partly to the expansion of cultivation area. During the past six years, average unit production of paddy increased by 3.3% per annum and reached the level of 3.3 /1 t/ha in 1973. The harvested area also increased from 8.0 million ha in 1968 to 8.4 million ha in 1973.

Although domestic agricultural production showed a considerable growth, food crop production was still insufficient to satisfy the domestic demand. Import of rice increased to 1.9 million tons in 1973 from 0.3 million tons in the previous year of 1972 and stayed at the high level of 1.1 million tons in 1974.

Sugar production was also not sufficient for domestic consumption in spite of the considerable growth of its production during the past seven years. The shortage was covered by import, which amounted to 150 thousand tons in 1975.

Table I-6 Output of Main Agricultural Products in Indonesia

(10^3t)

	1968	1969	1970	1971	1972	1973	1974 /*
Paddy (milled rice)	22,435 (11,666)	23,556 (12,249)	25,269 (13,140)	26,392 (13,724)	25,351 (13,183)	28,091 (14,607)	29,715 (15,452)
Maize	3,166	2,293	2,825	2,606	2,254	3,690	3,240
Cassava	11,356	10,917	10,478	10,690	10,385	11,185	13,775
Peanut	287	267	281	284	282	290	315
Soybean	420	389	498	516	518	541	550
Sugar	602	723	713	834	889	820	1,025

Source: Indikator Ekonomi Nov. 1975
Note : /* Preliminary figures

/1 Paddy is expressed in terms of dry stalk paddy in this report unless otherwise mentioned.

Table 1-7 Import of Rice in Indonesia

Year	Volume (10^3 ton)	Value (10^6 US$)
1968	485.9	96.4
1969	238.2	45.1
1970	323.9	52.2
1971	119.5	19.9
1972	334.6	49.7
1973	1,862.7	381.6
1974	1,132.1	374.2
1975/1	443.8	200.5

Source: Indikator Ekonomi Nov. 1975
Note : /1 From Jan. to June '75

1.2.3 International Trade

Indonesia has increased its export at a high rate of 47% per annum for the past seven years during 1968 - 1974. Export structure of Indonesia is characterized by its heavy dependence on the primary products such as mineral resources and agricultural products. Particularly, petroleum and petroleum products have become the most important export goods, whose share in the total exports increased from about 40% in 1968 to 70% in 1974, reflecting the quadrupled price increase of oil. Although their share has been decreasing, agricultural products such as rubber, coffee, palm oil, tea and wood are still important exporting commodities.

Imports of Indonesia have increased at a relatively low growth rate of 32% per annum compared with that of exports. Capital goods and raw materials are major items that have been imported with the respective shares of 40% and 41% in the total imports in 1974. The share of consumptive goods was only 18%, but in which rice import amounted to 53% in 1974.

The balance of the trade in recent years showed an increasing surplus from US$14.9 million in 1968 to US$3,584.4 million in 1974. The major factors affecting the improved balance were the increase of oil price and the world economic boom.

The balance of payment also showed a considerable improvement resulting from the favourable trade balance and a substantial inflow of foreign capital. Consequently the gross official reserves climbed up from US$160 million at the end of 1970 to US$1,624 million at the close of 1974. But the situation again changed for the worse due to the recent recession of the world economy, and the foreign reserves decreased to US$586 million at the end of 1975.

Table I-8 Balance of Trade in Indonesia

(10^6 US$)

Year	Including Petroleum & Products			Excluding Petroleum & Products		
	Exports	Imports	Balance	Exports	Imports	Balance
1968	730.7	715.8	14.9	433.2	709.7	-276.5
1969	853.7	780.7	73.0	470.8	769.8	-299.0
1970	1,108.1	1,001.5	106.5	661.8	986.8	-325.0
1971	1,233.6	1,102.8	130.8	755.7	1,082.4	-326.7
1972	1,777.7	1,561.7	216.0	864.6	1,531.4	-666.8
1973	3,210.8	2,729.1	481.7	1,602.1	2,685.3	-1,083.2
1974	7,426.3	3,841.9	3,584.4	2,214.9	3,658.9	-1,444.0
1975/1	3,337.6	2,404.1	933.5	841.1	2,275.8	-1,434.7

Note: /1 From January to June, 1975
Source: Indikator Ekonomi, Nov. 1975

Table I-9 Exports by Economic Group in Indonesia

(10^6 US$)

	Group A/1	Group B/2	Petroleum & Products	Total
1968	345.7	87.5	297.5	730.7
1969	389.3	81.5	382.9	853.7
1970	454.4	207.4	446.3	1,108.1
1971	431.3	324.4	477.9	1,233.6
1972	431.2	433.3	913.1	1,777.7
1973	711.0	891.1	1,608.7	3,210.8
1974	979.3	1,235.6	5,211.4	7,426.3
1975/3	388.5	452.6	2,496.5	3,337.6

Note: /1 Consists of rubber, copra, coffee, palm oil, tobacco, pepper and tin.

/2 Consists of tea, copra cake, fibre, rattam copar and damar, wood and others.

/3 From January to June 1975.

Source: Indikator Ekonomi Nov. 1975

Table I-10 Imports by Economic Group in Indonesia

(10^6 US$)

	Consumption Goods			Raw Materials	Capital Goods	Total
	Rice	Others	Total			
1968	96.4	170.1	266.5	259.7	189.6	715.8
1969	45.1	175.8	220.9	321.0	238.8	780.7
1970	52.2	198.9	251.1	376.5	373.9	1,001.5
1971	19.9	190.3	210.2	428.0	464.6	1,102.8
1972	49.7	202.1	251.8	597.7	712.2	1,561.7
1973	381.6	267.1	648.7	973.2	1,107.2	2,729.1
1974	374.2	332.8	707.0	1,582.3	1,552.6	3,841.9
1975/1	200.5	191.0	391.5	990.1	1,022.5	2,404.1

Note: /1 From January to June 1975

Source: Indikator Ekonomi Nov. 1975

1.3 THE SECOND FIVE YEAR DEVELOPMENT PLAN (PELITA II)

In 1973, Pelita-II was formulated for the years of 1974 - 1978. The Plan places the primary emphasis on the following basic policies;

i) to provide sufficient food and clothings at low price and in better qualities,

ii) to provide housing facilities together with necessary fittings,

iii) to continue the construction of the infrastructure,

iv) to improve national welfare and promote its equitable distribution, and

v) to expand employment opportunities.

In quantitative terms, the target of the Plan is set at an average annual growth rate of real GDP by 7.5% which is slightly higher than that of the previous plan (Pelita-I). Real GDP is expected to increase by 44% at the end of the Plan.

Under the national policy mentioned above, detailed programs of development are set forth for each economic sector. Main focus of economic development is laid on such sectors as industry, mining, power and transportation, besides agriculture.

The target and the expected growth rate of the development for each sector are set out in Table 1-12.

Although the share of the agricultural sector in GDP indicates a declining tendency, the sector is still the most important one for the country to attain self sufficiency in food and is expected to increase its output at an annual rate of 4.6%.

For the development of the agricultural sector, principal policies are mapped out as follows;

i) to increase the productivity in agricultural sector,

ii) to achieve self-sufficiency in food by emphasizing rice production,

iii) to increase exports of agricultural products through the production increase,

iv) to reduce unemployment and underemployment now prevailing in the villages,

v) to achieve a balanced growth between agricultural sector and industrial sector, and

vi) to utilize natural resources with necessary measures for their conservation.

In order to attain the above targets, an introduction of the irrigation farming is indispensable in this country where surface water is quite limited.

At the beginning of the Pelita-I, it was contemplated that more than 60% of the existing irrigation systems would require rehabilitation and improvement works. During Pelita-I, they were partly improved and are scheduled to be completed by the end of the Pelita-II. In addition, the Government of Indonesia goes on further strategic plans for agricultural development under Pelita-II. The strategic plans are reclamation of swampy land, prevention of flood over farm land, exploitation of new water resources and their effective utilization and construction of multipurpose dams.

Under these principles, detailed policies are worked out particularly for rice production. In the Plan, it is projected that the rice production will increase from 14.6 million tons in 1973 to 18.2 million tons in 1978, the growth equivalent to a compound rate of 4.5% a year.

In Central Java, targets of agricultural production are set for main food crops and estate crops. As for rice production, intensified production is emphasized and annual increase of its production is anticipated at the rate of 5.3% by intensive method. Sugar production is also expected to grow at a relatively high annual rate of 5.6%.

Table I-11 Allocation of Budget under Pelita II

(Rp. 10^9)

Sector	Allocated for 1974/1975	(%)	Pelita II	(%)
Agriculture & Irrigation	120.8	(19.6)	1,001.6	(20.6)
Industry & Mining	12.8	(2.1)	185.8	(3.8)
Electricity	55.7	(9.0)	387.8	(8.0)
Transp. & Tourism	111.4	(18.1)	831.7	(17.1)
Commerce & Cooperatives	4.2	(0.7)	37.9	(0.8)
Manpower & Immigration	6.6	(1.1)	69.4	(1.4)
Regional Development	127.7	(20.7)	930.6	(19.2)
Religion	1.6	(0.3)	15.0	(0.3)
Education & Culture	55.6	(9.0)	525.8	(10.8)
Welfare & Family Planning	23.3	(3.8)	192.1	(4.0)
Houseing & Water Supply	6.6	(1.1)	101.6	(2.1)
National Defense	20.0	(3.2)	156.0	(3.2)
Information	2.0	(0.3)	26.7	(0.5)
Science & Technology	11.1	(1.8)	101.3	(2.1)
National Organization	20.5	(3.4)	123.0	(2.5)
Government Capital Expenditure	35.2	(5.8)	172.5	(3.6)
Total	615.7	(100.0)	4,858.8	(100.0)

Table I-12 Expected GNP Structure Before & After Pelita II

(%)

Sector	1973/1974 (Estimated)	Av. Annual Growth Rate during Pelita II	1978/1979
Agriculture	40.2	(4.6)	35.6
Mining	9.2	(9.0)	9.9
Industry	9.8	(13.0)	12.5
Construction	3.7	(9.2)	4.0
Transportation & Communication	4.1	(10.0)	4.7
Others	33.0	(7.6)	33.3
Gross Domestic Product	100.0	(7.5)	100.0

Source: Pelita II

Table I-13 Targets of Agricultural Production, Pelita II
Central Java

Crops			Growth Rate (%)
Food Crops			
Rice	a)	Intensified Production	
		- increase area	4.5
		- increase production	5.3
	b)	Non Intensified Production	
		- decrease area	7.5
		- decrease production	5.0
	c)	Overall	
		- increase area	1.0
		- increase production	2.49
Maize (Overall)			
		- increase area	3.7
		- increase production	6.35
Cassava (Overall)			
		- increase area	1.31
		- increase production	5.92
Sweet Potato (Overall)			
		- increase area	2.90
		- increase production	3.28
Estate Crops			
Rubber			2.6
Tea			2.6
Coffee			2.5
Cacao			3.0
Kapok			3.1
Coconut			2.0
Pepper			4.0
Cloves			11.0
Sugar			5.6
Fiber			8.0
Tobacco			5.0

2. PRESENT SETTING OF AGRICULTURE IN THE PROJECT AREA

2.1 GENERAL

The project area is situated in the upper Sala river basin extending over the flat alluvial plain between the altitude of 75 m to 105 m, which covers four Kabupatens, namely, Sukoharjo, Klaten, Karanganyar and Sragen.

Total population is estimated at 250,000 with the population density of 800 persons/km^2. More than 60% of the working population is now engaged in agricultural sector. This fact indicates that the project area is an over populated area with its economy heavily dependent on agriculture.

The project area is already developed and there is no room for new reclamation. Although about 70% of the project area is classified into technical or semi-technical irrigation area, the percentage of the rice planting area in the dry season is less than 30% of the project area, which means that the water provided by the existing irrigation system is not sufficient in the project area.

With respect to farm economy, farmers get their income mainly from the sales of farm crops particularly paddy, since paddy is the predominant crop cultivated in the project area. However, due to the small scale (0.52 ha per farmer) and less intensive use of the cultivated land, farm crop production is rather limited and the farm economy is still on a subsistence level.

2.2 POPULATION

Total population in the project area covering parts of four Kabupaten, namely Sragen, Sukoharjo, Klaten, Karanganyar, was estimated at about 250,000 in 1971.

As explained in the preceding chapter, population density is very high in Central Java and the situation is almost the same or worse in the project area. The population density of the project area is estimated at 800 persons per km^2, indicating a high population pressure which is manifested in unfavourable land/man ratio and minute land holdings.

Population growth rate is relatively high in the project area compared with that of Central Java. During 1961 to 1971, the population increased by more than 1.8% per annum in Sragen, Sukoharjo and Karanganyar, while it increased only by 1.5% per annum in Klaten.

Although urbanization is proceeding, rural population is predominant in the project area and a large part of the population is still involved in agricultural activity. According to the recent population census, about 64% of the working population is engaged in agricultural sector, and the remaining 36% in non-agricultural sector such as trade, government services and others.

Average size of a farm family in the project area is about 4.9 persons of which two are farm workers.

From these population structure, the project area is characterized by over population with its economy heavily dependent on agricultural sector. Although any reliable statistics for employment are not available, it is considered that there exists substantial unemployment and under-employment in the project area.

2.3 LAND HOLDING AND LAND TENURE

According to the agricultural census in 1973, about 85% of the farmers owned the cultivated land less than 1.0 ha in Central Java, while only some 15% of farmers possessed the land larger than 1.0 ha. Particularly, the number of the smallest land owner less than 0.5 ha occupied about 60% of the total farmers.

From the data collected in Kabupaten, distribution of the land holding in the project area is proved to be almost the same as that of Central Java; some 80% of the farmers are classified into small farmer each owning less than 1.0 ha. The average land holding per farmer is estimated at 0.52 ha in the project area.

With respect to land tenure, about 66% of the total land is now cultivated by landowners themselves, 32% partly by landowners and partly by tenants and the remaining 2% by tenants in Central Java. According to the farm survey, about 80% of the land is cultivated by land owners and 20% by tenants in the project area.

There exist two kinds of land tenure systems, namely Sewa (lease with fixed cash rent) and crop sharing system. For Sewa, land rent is to be paid in cash to the owner in fixed rate, which is ranging from Rp. 20,000 to Rp. 190,000 per ha per year depending on the land condition. The cost of crop production and land tax are borne by the tenant.

Two different crop sharing systems of Maro and Mertelu are prevailing in the project area. In Maro system, land owner and tenant divide the total products into equal share and all the production costs are borne by the tenant except land tax. In Mertelu system, land owner takes 2/3 and tenant takes 1/3 of total products. All the production costs are borne by the tenant except land tax as in the case of Maro system.

In the project area, Sewa is the most popular system of land tenancy, while Maro system and Mertelu system are negligibly small in area.

2.4 SOIL AND LAND CLASSIFICATION

2.4.1 Introduction

Soils in the Project area were surveyed by Dames[/1] in 1955 and the staff[/2] of the Soil Research Institute in Bogor in 1973. On the basis of the survey in east Central Java, soil maps were prepared on a scale of 1 to 250,000.

The soil survey, carried out this time, aims at identifying major soils and their distribution and examining the adaptability of each soil for irrigation farming, refering to the said soil maps.

This report presents the procedure of the survey, and the descriptions on the main features of the major soils, the new soil map and the the land capability map.

2.4.2 Procedure of Soil Survey

The field survey was carried out over the area of 39,400 ha by using the topographic map of 1/20,000 scale which was scaled down from the original 1/5,000 map. The soil profiles were observed in pits dug at the rate of one per 250 ha and were described according to the standards defined in the Soil Survey Manual of the United States Department of Agriculture. The pits were dug to a depth of about one meter. In the inundated land, the pits were enclosed in the dikes to prevent the water from running into pits.

150 pits were dug out and 21 soil samples were taken from the representative soil horizon. These soil samples were sent to the Gadjah Mada University and were analized. The items checked at the analysis were pH value, exchangeable bases, total carbon, particle size distribution analysis, free iron, available P_2O_5, plastic limit and shrinkage limit, sticky point, $CaCO_3$, nitrogen, cation exchange capacity, exchangeable hydrogen, and specific density. The results are shown in Table I-14.

/1 T.W.G. Dames: (1955) The Soils of East Central Java.

/2 Soil Research Institute in Bogor: (1973), Soil and Land Capability in Bengawan Solo Basin.

Table I-14 Results of Soil Analysis

Kind of soil	Pit No.	CEC (m.e)	H^+ (m.e)	B.S.D (%)	C (%)	OM (%)	N Total (%)	pH H2O	pH KCl	Fe (%)	CaCO3 (%)	Clay (%)	Silt (%)	Sand (%)	Soil texture
Alluvial soil (soil series C)	2/I	57.36	14.38	74.93	2.20	3.79	0.15	5.7	4.9	1.93	0.38	64.62	34.62	0.76	C
	II	57.21	11.21	80.40	1.74	3.00	0.10	6.1	5.5	1.25	0.64	68.22	24.89	6.89	C
	III	57.11	11.63	79.63	1.30	2.24	0.06	6.2	5.6	1.07	0.44	71.51	26.44	2.05	C
	IV	57.99	12.25	78.87	1.32	2.28	0.09	5.8	5.6	0.93	0.73	66.87	23.16	9.97	C
Hydromorphic Soil (soil - series F)	9/I	57.03	12.07	78.83	2.61	4.49	0.13	6.4	5.6	0.04	0.35	69.93	28.84	1.23	C
	II	57.02	9.83	82.76	1.74	2.99	0.10	5.6	5.5	0.36	0.47	59.91	29.10	10.99	C
	III	57.72	11.30	81.41	1.31	2.26	0.08	6.5	5.0	0.86	0.51	61.18	33.43	5.39	C
	IV	57.05	11.18	80.40	1.76	3.04	0.06	6.6	5.6	0.46	0.41	63.03	30.17	6.80	C
Hydromorphic soil (soil - series F)	15/I	57.58	11.72	79.64	2.63	4.53	0.20	6.4	6.5	0.28	0.60	60.37	27.53	12.11	C
	II	57.14	9.85	82.76	2.60	4.48	0.18	6.7	6.8	0.21	0.61	61.26	25.55	13.19	C
	III	57.20	7.62	86.67	2.17	3.75	0.13	7.3	6.4	0.29	0.49	60.51	26.66	12.83	C
Alluvial soil (soil series C)	22/I	55.70	17.09	69.31	1.70	2.93	0.13	5.4	4.7	1.83	0.56	47.35	35.87	16.78	C
	II	556.32	15.30	72.83	0.95	1.64	0.12	5.7	5.0	1.81	0.71	52.14	30.70	17.16	C
	III	56.29	12.35	78.06	1.28	2.21	0.07	5.1	5.2	1.87	0.51	49.02	14.36	36.62	C
Hydromorphic soil (soil - series E)	40/I	55.48	13.90	74.94	1.68	2.89	0.11	5.2	4.6	1.94	0.42	50.65	19.97	29.38	C
	II	55.37	11.72	78.83	1.68	2.90	0.09	6.0	5.4	1.94	0.28	48.77	30.97	20.26	C
	III	53.75	6.79	87.36	0.85	1.46	0.05	6.5	6.3	1.85	0.48	33.54	10.52	55.54	SCL
	IV	56.09	10.55	81.19	1.23	2.13	0.06	6.3	5.9	2.76	0.42	54.36	29.04	16.60	C
Grumusols(soil - series A)	43/I	56.81	11.58	79.61	2.59	4.47	0.10	4.6	4.0	0.97	0.16	61.36	25.20	13.44	C
	II	56.44	11.07	80.38	1.72	2.97	0.09	6.1	5.2	0.89	0.65	70.31	5.59	24.10	C
	III	57.42	8.55	85.10	1.75	3.02	0.06	6.5	5.6	0.70	0.44	65.11	19.87	15.02	C

Remarks
CEC : Cation exchange capacity
H^+ : Exchangeable hydrogen
B.S.D. : Base saturation degree
C : Total carbon
OM : Organic matter
N total : Total nitrogen
Fe : Free iron
C : Clay
SCL : Sandy clay loam

- Continued -

Pit No.	Bulk density	Exchangeable cation (me) Ca	Mg	Shrinkage limit (%)	Plastic limit (%)	PO_4 (ppm)
2/I	2.2	17.3	5.7	14.9	62.4	31.5
II	2.1	18.5	3.3	15.2	53.8	28.3
III	2.0	18.9	3.7	17.4	64.6	34.9
IV	2.0	21.7	0.8	17.1	77.7	32.0
9/I	2.0	19.6	5.0	16.6	72.0	37.5
II	2.0	21.3	5.9	14.6	68.4	55.7
III	2.0	21.5	4.5	17.7	75.2	38.1
IV	2.1	20.5	5.8	17.9	72.5	32.5
15/I	2.0	22.9	4.3	17.4	77.7	46.1
II	2.0	24.0	5.0	17.5	77.2	37.6
III	2.1	25.0	2.8	14.9	77.2	45.4
22/I	2.5	11.1	3.1	11.0	59.1	39.4
II	2.2	9.9	0.3	12.1	53.9	52.1
III	2.1	9.2	2.2	12.6	52.7	39.4
40/I	2.4	6.7	0.9	10.5	42.3	47.3
II	2.4	8.5	0.8	11.4	43.6	36.6
III	2.7	6.7	0.8	7.4	35.8	84.0
IV	2.0	9.5	0.6	15.1	51.5	47.9
43/I	2.1	11.4	3.0	15.1	61.9	3.8
II	2.1	14.3	3.7	12.1	70.4	13.2
III	2.0	15.5	4.8	12.6	69.3	36.2

2.4.3 Soil Classification and Main Features of the Major Soils

Most soils prevalent in the project area have much been weathered through various hydromorphic soil formation process under humid climatic conditions and topographic conditions.

In the light of the morphological characteristic and the results of laboratory tests, soils in the project area are classified into four great soil groups, namely, grumusols, alluvial soils, lithosols and hydromorphic soils.

Grumusols

The grumusols mainly extend over the northern part of the project area, Sragen area on the flat land and the piedmont of Mr. Lawu. The total area of the grumusols is 14,800 ha, equivalent to 37.6% of the total surveyed area.

The horizon sequence of these soils is A/C or A/Cca in general.

These soils have a characteristic of darkened surface (10YR4/1 to 10YR2/1). The structure of the lower A and C horizons shows blocky structure with slickensides and it is strongly effected by the expansion and contraction of the soil mass with changes in moisture content. When the soils dry up, they become hard like rocks and cracks occur. Most cracks reach a depth of 50 cm.

The texture of the soil is clay throughout the profile.

As far as chemical properties are concerned, the pH values range between 6 and 7.5 in H_2O and between 5 and 6 in IN-KCl solution. But the pH shows higher values, where the $CaCO_3$ content is high. The content of organic matter is relatively low and shows about 4% for the surface soil. Cation exchange capacity shows about 55 milligram equivalnet per 100 grams of soils throughout the profile. The exchangeable base content is so high that base saturation degree shows high degree of about 80%, and its value increases with depth. Calcium and magnesium are major bases. The nitrogen content is less than 0.1%. The available P_2O_5 is poor. The free iron content is about 0.9% and low.

With regard to soil conservation, these soils are very susceptible to erosion by the strong rainfall over short periods, because they have low infiltration, low permeability and often poor surface soils which have progressively developed to a granular structure or cauliflower-like structure under the influence of successive wetting and drying. Soil erosions (gully erosion) are often found at the isolated high land located north of Sragen city and at the area along the small tributaries of the Sala river.

In the light of soil features, grumusols is suitable for irrigation farming of rice, sugar cane, and polowijo crops under the proper farming practices including application of chemical fertilizers and

manures, proper irrigation and drainage system, some measures (terracing, contour cultivation) to prevent soil erosion on sloping land, conditioning heavy texture of soils, etc.

These grumusols are further divided into two soil series, soil series A and soil series B depending on whether tuffaceous sandy clayey material layer, locally called Padas, exists within the depth of one meter or not. The tuffaceous material layer is very poor for irrigation farming.

	Area (ha)
Soil series A (no tuffacous materials)	9,600
Soil series B (with tuffacous materials within the depth of 1 m).	5,200

The typical soil profiles are shown below.

Soil series A

Pit No.	43
Location	Bulakredjo
Land use	Paddy-field (wet season paddy-dry season paddy)
0 - 15 cm	brownish black (10YR 3/1) clay; massive structure, diffuse smooth boundary
15 - 25 cm	brownish gray (10YR 4/1) clay; weak coarse blocky structure; few iron mottling and few manganese concretions; slickensides; plastic; sticky.
25 - 100 cm	brownish gray (10YR 4/1) clay; coarse blocky structure; many to prominent iron mottling and few manganese concretions; slickensides; plastic; sticky.

Soil series B

Pit No.	134
Location	Ds. Made
Land use	Paddy field (wet season paddy-polowijo)
0 - 15 cm	brownish gray (10YR 4/1) caly; few iron mottling; plastic; sticky; diffuse smooth boundary.

15 - 50 cm	brownish gray (10YR 5/1) clay; few iron mottling and many manganese concretions; very weak blocky structure; plastic, sticky; diffuse smooth boundary.
50 - 75 cm	grayish yellow brown (10YR 5/2) clay; coarse blocky structure; few iron mottling and manganese concretions; slickensides; plastic; sticky; abrupt smooth boundary.
75 cm +	tuffacous clay hard pan.

Alluvial Soil

The soils of this group extend over the natural levee and flood plains along the Sala river and its tributaries. The soils of this group cover an area of 2,500 ha equivalent to 21.6% of the total surveyed area.

Generally these soils are inmature with no morphological characteristics. The sequence of these soils is IC/IIC or A/C.

The thickness of A horizon is less than 20 cm in general. A horizon (surface soil) is brownish gray to grayish brown (10YR 4/1) to 7YR 4/2) clay. The clay content is lower than that of grumusols. The soil is subsoils which consists of clayey texture. The structure is massive in surface soil and becomes fine to coarse blocky in subsoil.

With regard to chemical properties, soils of this group have pH value between 5.5 and 6.5 for H_2O and between 4.9 and 5.6 for IN-KCl solution throughout the soil profile. The cation exchange capacity throughout the profile shows about 57 milligram equivalent per 100 grams of soils. Main exchangeable base is Ca and base saturation degree shows high value of 80%. The nitrogen content is less than 0.15%. The available P_2O_5 is poor. The free iron content is about 1.9%.

Generally land covered with this alluvial soil is subject to annual flooding for the short period from the Sala river and its tributaries.

In the light of soil features, alluvial soils is suitable for irrigation farming of rice, sugar cane, polowijo crops, etc. by drainage facilities, implementing countermeasures for flooding, and applying proper fertilizers.

The typical profile of these alluvial soils is shown below.

Soil series C

Pit No. 2

Location	Kenteng
Land use	Paddy field (wet season paddy-dry season paddy).
0 - 15 cm	grayish yellow (10YR 4/2) clay; massive structure; plastic; sticky; diffuse smooth boundary.
15 - 30 cm	grayish brown (7.5YR 4/2) clay; very weak fine blocky structure; very few iron mottling; plastic; sticky; diffuse smooth boundary.
30 - 42 cm	brownish gray (7.5YR 4/1) clay; very weak fine locky structure; plastic; sticky; abrupt smooth boundary.
42 - 100 cm	brownish gray (10YR 4/1) clay; coarse to very coarse blocky structure; slickensides; very plastic; very sticky.

Lithosols

The lithosols develops over the isolated highly elevated land in the northern part of the surveyed area. The soils of this group cover an area of 200 ha, equivalent to 0.5% of the total surveyed area.

The horizon sequence of this soil is very shallow in depth or is lost by erosion. The land covered with lithosols is very stony. The volcanic rock and andesites often appear on the surface soil.

In the light of these soil features, lithosols have no agricultural potentiality for irrigation farming.

Hydromorphic soils

The soils of this group extend over flat plain and very gently sloping land on the skirt of Mr. Lawu adjacent to alluvial soils. The area covered with this soil groups is 15,900 ha, equivalent to 40.3% of the surveyed area. In general, hudromorphic soils extening over the northern part of Surakarta city have developed from the volcanic material alluviums overlying tuffaceous materials. The hydromorphic soils located in the southern part of Surakarta have developed from the volcanic material alluviums overlying grumusols.

These hydromorphic soils are further divided into three soil series, soil series E, soil series F and soil series G according to the morphological characteristic.

The soils of soil series E extend over mainly relatively high flat or sloping land in Sukoharjo area having relatively good drainage condition. Total area of these soils is 2,800 ha or

7.1% of the total surveyed area. The horizon sequence of these soils is AG/Bir/C or AG/Bir/CG, in general.

The thickness of AG horizon is less than 20 cm. The ploughsoles are found at the depth of 15 to 20 cm below the surface. A horizon is yellowish gray (2.5 Y 4/1) clay. The structure of A horizon (surface) is massive or very weak blocky. The B horizon has weak fine blocky structure and the structure becomes coarse blocky with soil depth. The B horizon which has iron accumulation is dull yellowish brown clay. Also many manganese concretions are found in this horizon. These soils also crack on a small scale when dried up.

As far as chemical properties are concerned, soils of this group have pH value between 5 and 6.2 in H_2O and between 4.5 and 6.3 in 1N-KCL solution throughout the soil profile. The cation exchange capacity is about 55 milligram equivalent per 100 grams of soils. Main exchangeable base is Ca and the base saturation degree shows about 80%. The nitrogen content on the surface is about 0.09 which decreases in proportion to depth. The available P_2O_5 is poor. Free iron content shows 1.9% which is relatively high.

In the light of soil features, soil series E is suitable for irrigation farming of rice, sugar cane, polowijo, etc. under proper farming practices including application of chemical fertilizers as well as manure, proper irrigation water management, etc.

The typical profile of this soil series is shown as follows.

Soil series E

Pit No.	40
Location	Tegalrejo
Land use	Fallow
0 - 15 cm	yellowish gray (2.5 Y 4/1) clay; massive structure; plastic; sticky; diffuse smooth boundary
15 - 20 cm	dull yellowish brown (10 YR 4/3) clay; medium blocky structure; prominent manganese concretions and iron mottling; plastic; sticky; diffuse smooth boundary
20 - 60 cm	brown (10 YR 4/6) clay loam; medium blocky structure; prominent iron mottling and many manganese concretions; plastic; sticky; smooth diffuse boundary.
60 - 100 cm	dull yellowish brown (10 YR 4/3) clay; medium to coarse blocky structure; many manganese

concretions; few gley spots; slickensides; plastic; sticky.

The soils of soil series F extend over the very poorly drained, flat or depressed land, adjacent to alluvial soils in lower part and to hydromorphic soil in higher part. The area covered with the soils of this group is 8,200 ha equivalent to 20.8% of the total surveyed area. The horizon sequence of these soil is AG/BG/CG or AG/G. The AG horizon is less than 20 cm in thickness. The ploughsole is very weakly developed at the depth of 15 to 20 cm. The AG horizon (surface soil) is dark greenish gray (10 GY 4/1) clay with massive structure. The subsurface soil is yellowish gray (2.5 Y 4/1) fine textured soil with weak medium blocky structure. The soils thoughout the profile are gleyed. The subsurface soils have few to many iron mottlings and manganese concretions. With regard to chemical properties, pH values are between 5.6 and 6.6 in H_2O and between 5.0 and 5.6 in IN-KCL solution throughout the profile. The organic matter is low of 4% in surface soil. Cation exchange capacity shows about 57 milligram equivalent per 100 grams of soil. Major exchangeable base is also Ca and base saturation degree shows about 80%. The nitrogen and available P_2O_5 contents are low. Free iron content is low of about 0.64%.

In the light of soil features, soil series F is suitable for irrigation farming of rice, sugar cane, polowijo crops by implementing proper irrigation and drainage facilities, sometimes countermeasures for flooding, and applying proper chemical fertilizers as well as manure.

The typical profile of this soil series is shown below.

Soil series F

Pit No.	9
Location	Tumpukan
Land use	Paddy field (Wet season paddy-Dry season paddy)
0 - 15 cm	dark greenish gray (10 GY 4/1) clay; sticky; diffuse smooth boundary
15 - 30 cm	yellowish gray (2.5 Y 4/1) clay; weak medium blocky structure; very few iron mottling plastic; sticky; diffuse smooth boundary
30 - 50 cm	yellowish gray (2.5 Y 4/1) clay; very coarse blocky structure plastic; sticky; diffuse smooth boundary
50 - 100 cm	yellowish gray (2.5 Y 4/1) clay; very coarse blocky structure; slickensides; iron and manganese mottling; plastic; sticky.

The soils of series G extend over the poorly drained flat land located south of Surakarta city. The area of this soil group is about 4,900 ha or 12.4% of the total surveyed area. The soil series G is the same as soil series F except that soil series G has a tuffaceous sandy or clayey materials (so called Padas) within the depth of one meter.

The typical profile of this soil series is shown as follows.

Soil series G

Pit No.	79
Location	Bekar
Land use	Paddy field (wet season paddy-dry season paddy)
0 - 15 cm	yellowish gray (2.5 Y 4/1) clay; massive structure; plastic; sticky; diffuse smooth boundary
15 - 30 cm	gray (5Y 5/1) clay; massive structure; plastic; sticky; many gley spots, diffuse smooth boundary
30 - 50 cm	gray (1 Y 5/1) clay; weak blocky structure; plastic; sticky; abrupt smooth boundary
50 cm +	hard pan (tuffaceous sandy materials)

2.4.4 Land Capability

Based on the above results of the soil survey, the land in the project area is classified into four classes, namely, I, II, III and IV in accordance with modified classification of the standard of the Ministry of Agriculture and Forestry in Japan as follows. Distribution area classified by land capability is illustrated in the attached Land Capability Map.

Class I Very suitable for irrigation farming

The land covered with this class has very effective deep soil depth with fine soil texture. The land is low in permeability and has favorable external drainage. There are no problems of flood damages and soil erosion. Nutrient status is poor. Proper fertilization is essential for increased agricultural production. The lands of this class occupy 2,600 ha or 6.6% of the surveyed area.

Class II Suitable for irrigation farming

Class II-A

The land covered with this class has relatively shallow effective soil depth (ranging from 25 to 50 cm). The land is poorly drained, fine in texture, low in permeability and poor in nutrient status. There are no problems of flood damages and soil erosion. For successful increased agricultural production, improvements in drainage will be required under the proper fertilization. The effective soil depth is relatively shallow so that land preparation should be done carefully not so as to mix the surface soils with tuffaceous materials (Padas) in subsoils.

The lands of this class occupy 1,000 ha or 2.5% of the surveyed area.

Class II-B

The land covered with this class has very deep effective soil depth with fine soil texture. The land is poorly drained and very low in permeability. The soils of this land are poor in nutrient status, especially free iron content. There are no problems of flood damages and soil erosions. Drainage improvements will be required under the proper fertilization for irrigation farming. For continual paddy cultivation for a long time the increase of iron content in this soil will be needed to prevent the soils from deterioration. The lateritic soils extending over the piedmont of Mt. Lawu are available for materials of high iron content to be supplied for this class II-B land.

The lands of this class occupy 11,100 ha or 28.2% of the surveyed area.

Class II-C

The land covered with this class has very deep effective soil depth with fine soil texture. The land is poorly drained and low in permeability. Nutrient status of this land is poor. The land has no problems of soil erosion but is sometimes subject to annual flood. Drainage improvement as well as flood control measures are essential for increased agricultural production. The proper fertilization is also required.

The lands of this class occupy 7,700 ha or 19.5% of the surveyed area.

Class II-D

The land of this class has very deep effective soil depth with fine soil texture. The land is very poorly drained and low in permeability. Nutrient status is poor. No flood and erosion problems occur. For increased agricultural production, drainage improvement will be required as well as proper fertilization.

The lands of this class occupy 12,100 ha or 30.8% of the surveyed area.

Class II-E

The land of this class has very effective soil depth with fine soil texture. The land is very poorly drained and is often subject to annual floods. Permeability is very low. Nutrient status is poor especially for free iron content. There is no problem of soil erosion. For increased agricultural production, drainage improvement as well as flood control measures are essential. Due to the soil deterioration, application of materials of high iron content such as lateritic soils will be needed in the near future. Proper fertilization is also essential for increased agricultural production.

The lands of this class occupy 400 ha or 1.0% of the surveyed area.

Class II-F

The land of this class has deep to relatively shallow effective soil depth with fine soil texture. The land is relatively steep with favorable external drainage. Sometimes, soil erosions are found but no flood damages occur. Soil nutrient is poor, especially for free iron. Contourcultivation with proper fertilization will be required.

The lands of this class occupy 2,800 ha or 7.1% of the surveyed area.

Class III Moderately suitable for irrigation farming

Class III-A

The land of this class has deep effective soil depth with fine soil texture. The land is very poorly drained and very low in soil permeability. The land is severely subject to annual flood for a considerable period. There is no problem of soil erosion. For increased agricultural production, flood control measures and drainage improvement are essentially required as well as proper fertilization.

The lands of this class occupy 900 ha or 2.3% of the surveyed area.

Class III-B

The land of this class has shallow effective soil depth (15 to 25 cm) with fine soil texture. The land is poorly drained and low in permeability. There are no problems of flood damages and soil erosion. Nutrient status is poor. Proper fertilization and drainage improvement are required for increased agricultural production. Land preparation will be carefully done due to the shallow effective soil depth. Soil dressing will be recommendable.

The lands of this class occupy 600 ha or 1.5% of the surveyed area.

Class IV Unsuitable for irrigation farming

The land of this class has very shallow effective soil depth and serious soil erosion problems. The lands of this class occupy 200 ha or 0.5% of the surveyed area.

2.5 LAND USE

The land under cultivation (gross irrigable area) is estimated at 23,500 ha out of the total area of 31,000 ha. The remaining areas are residential districts, roads, ditches, river, etc. The cultivated land consists of 23,200 ha of paddy field and 300 ha of upland field. The paddy field of 23,200 ha is defined as the project area for this irrigation project.

The irrigation facilities were installed relatively well but are now considerably deteriorated. The paddy field is classified into two categories, namely, technical and semi-technical irrigation area and non-technical or rainfed area, which are 15,840 ha and 7,360 ha, respectively. The land under irrigation is 67% of the gross irrigable area.

Predominant crop in the project area is paddy, which occupies about 80% of the total cultivated area in the wet season, followed by sugar cane and polowijo crops such as cassava, maize, soybean and peanut. Multi-cropping index/1 in the project area is about 1.5. Main hindrance to a high multi-cropping index is the uneven distribution of rainfall. Existing six reservoirs cannot supply sufficient quantity of irrigation water to the project area due to their limited capacities.

The paddy field is regionally classified into three representative areas, Sragen, Karanganyar and Dengkeng in terms of the existing irrigation system and land use. The characteristics of the land use are summarized in Table I-15 and the details in each areas are explained as follows.

/1 Multi-cropping index is calculated by dividing total planted area by total cultivable area.

Table I-15 Present Land Use

(ha)

	Sragen	Karanganyar	Dengkeng	Total
Paddy Field				23,200
(Irrigated/1)	(7,000)	(7,740)	(1,100)	(15,840)
(Non-Irrigated/2)	(2,500)	(2,360)	(2,500)	(7,360)
Wet season paddy	7,290	8,210	3,030	18,530
Dry season paddy	1,970	3,390	560	5,920
Sugar cane	1,250	580	-	1,830
Polowijo crops	2,820	4,320	1,440	8,580
Total	13,330	16,500	5,030	34,860
Multi-cropping index				1.50

Note: /1 Includes technical irrigated and semi-technical irrigated areas

/2 Non-irrigated and rainfed areas

Sragen area (9,500 ha)

The area is located northeast of Surakarta city on the right side of the lower reaches of the upper Sala river. The area is a relatively flat land with the elevation from 75 m to 86 m. The area consists of 7,000 ha of technical and semi-technical irrigation area and 2,500 ha of non-technical and rainfed area. Irrigation facilities are rather well established and their deterioration degree is relatively small. In addition to the irrigation facilities, four small reservoirs, Tewel, Kembangan, Gebyar and Brambang, provide irrigation water during the dry season although their capacities are limited. The cropping ratio/1 of the dry season shows 34% consisting of 21% for the dry season paddy and 13% for sugar cane. Sugar cane is planted on the irrigable area of 1,250 ha.

Karanganyar area (10,100 ha)

The area is situated at the right side of the Sala river between the Colo weir and Surakarta city. Topographically, the area extends over the flat and very gently sloping land with the elevation from 90 m to 105 m. The area is poorly drained land in general.

/1 Cropping ratio = Cropping area / Total cultivated area

The area consists of 7,740 ha of technical and semi-technical irrigation area and 2,360 ha of non-technical and rainfed area. The irrigation facilities are rather well installed, but additional rehabilitation of them is necessary. Two existing reservoirs, Mulur and Lalung have relatively large capacity and supply irrigation water during the dry season. The cropping ratio in the dry season is relatively high at 40% (34% for dry season paddy and 6% for sugar cane) which is the highest in the project area. The sugar cane area is 580 ha.

Dengkeng area (3,600 ha)

The area is located between the Colo weir and the Dengkeng river on the left side of the Sala river. Topographically, the area extends over the flat or partly depressed land in the elevation range of 90 m to 105 m. The land in this area is generally poorly drained.

The irrigation facilities are not well provided and 2,500 ha or about 70% of the area remains as non-technical irrigation area or rainfed area. Technical and semi-technical irrigation areas are only 1,100 ha. Since there are no reservoirs to supply irrigation water during the dry season, cropping ratio in the dry season drops to 16%. The area is subject to annual flooding. About 900 ha of the area is inundated for a long period from January to March. Due to these unfavourable conditions for agriculture production, sugar cane cultivation is not found in the Dengkeng area.

2.6 CROPPING PATTERN & FARMING PRACTICES

Typical cropping patterns are estimated for three areas on the basis of the collected data obtained from irrigation offices in the project area covering 10 years from 1966 to 1975. The results are presented in Fig. I-1 to I-3.

As indicated in the cropping patterns, paddy is the most important crop in the project area, followed by sugar cane while polowijo crops are planted widely for producing supplemental staple food.

Paddy cultivation is dependent on the onset of the rainy season and seedling period fluctuates from year to year/1. The late onset of the rainy season will definitely delay the planting time of the dry season paddy. Thence, the unit yield and the cultivation area in the dry season paddy are strongly affected by the availability of water supplied during the late growing stages of the dry season paddy.

In normal year, the wet season paddy is planted between early October and the middle of December and harvested between the middle

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/1 Refer Fig. I-4

Fig. I - 1 Present Cropping Pattern in Sragen Area

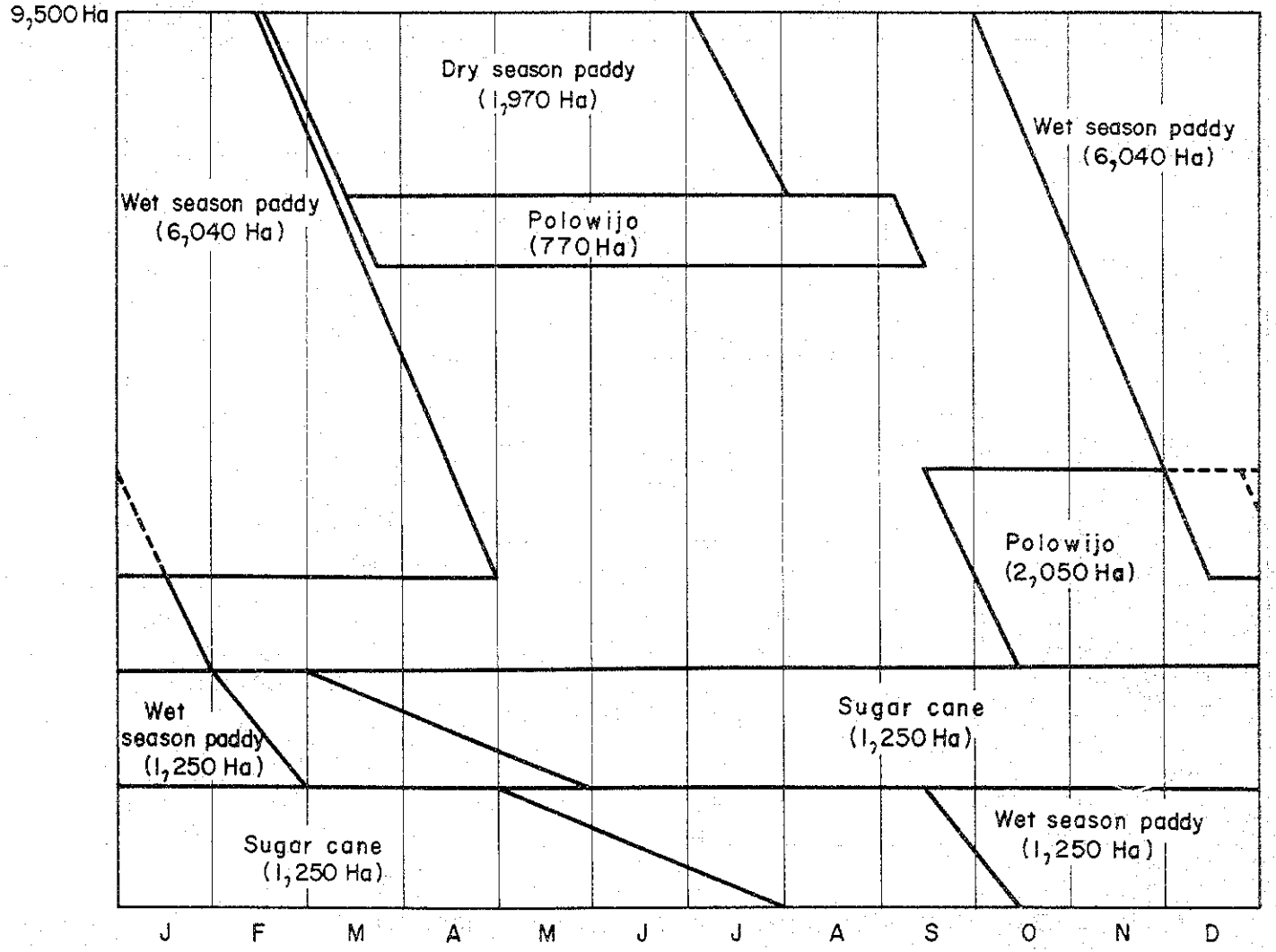


Fig. I-2 Present Cropping Pattern in Karanganyar Area

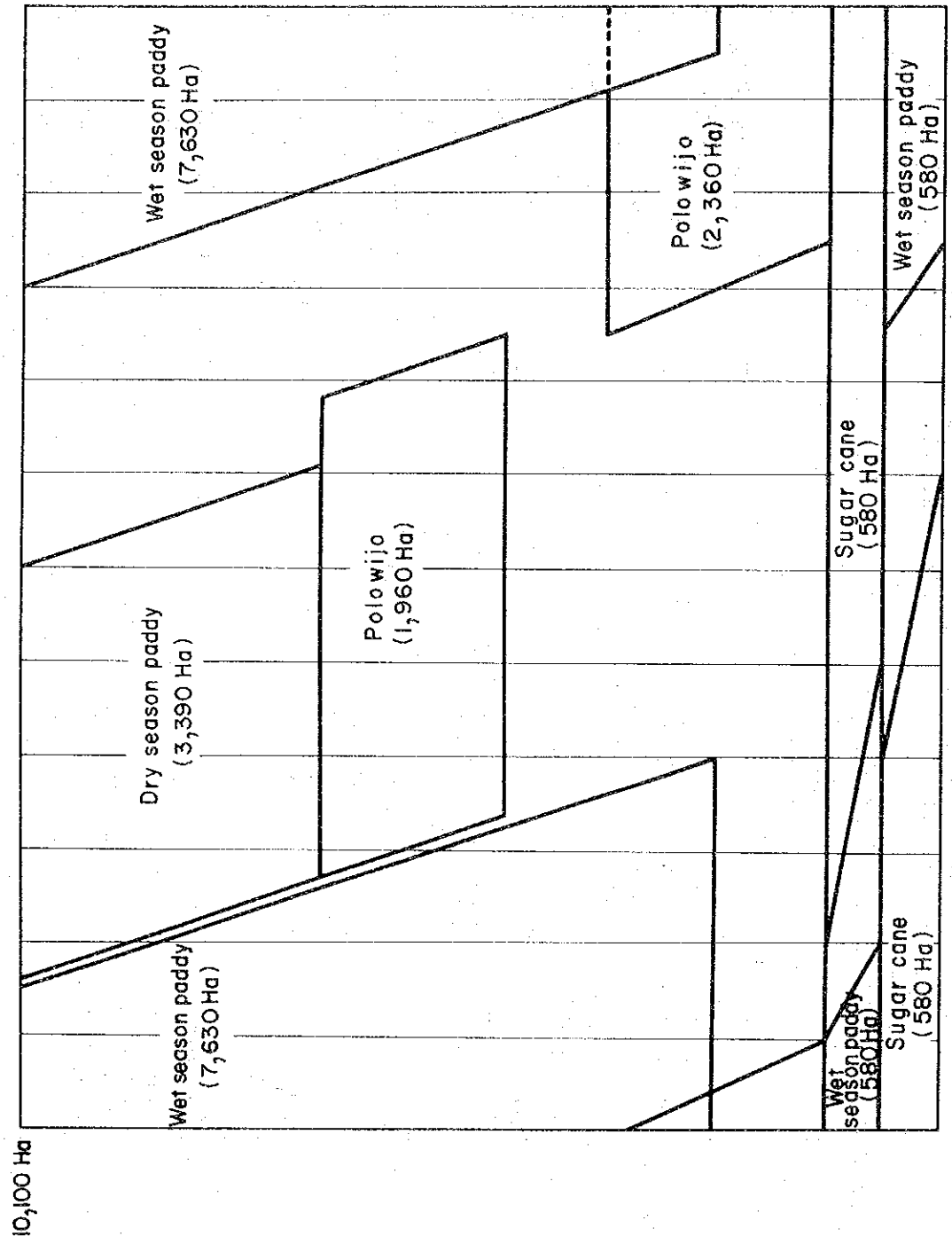


Fig. I-3 Present Cropping Pattern in Dengkeng Area

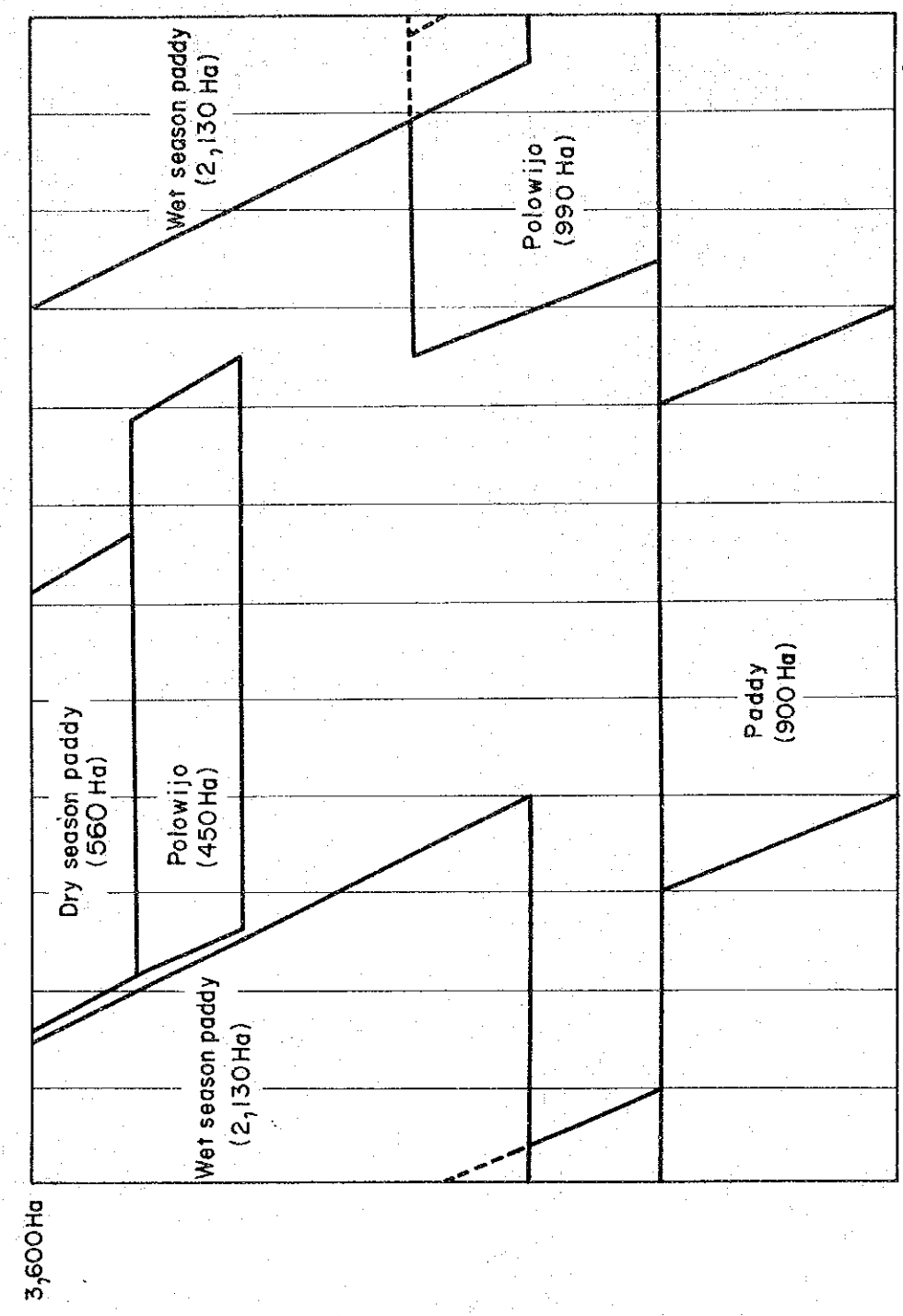
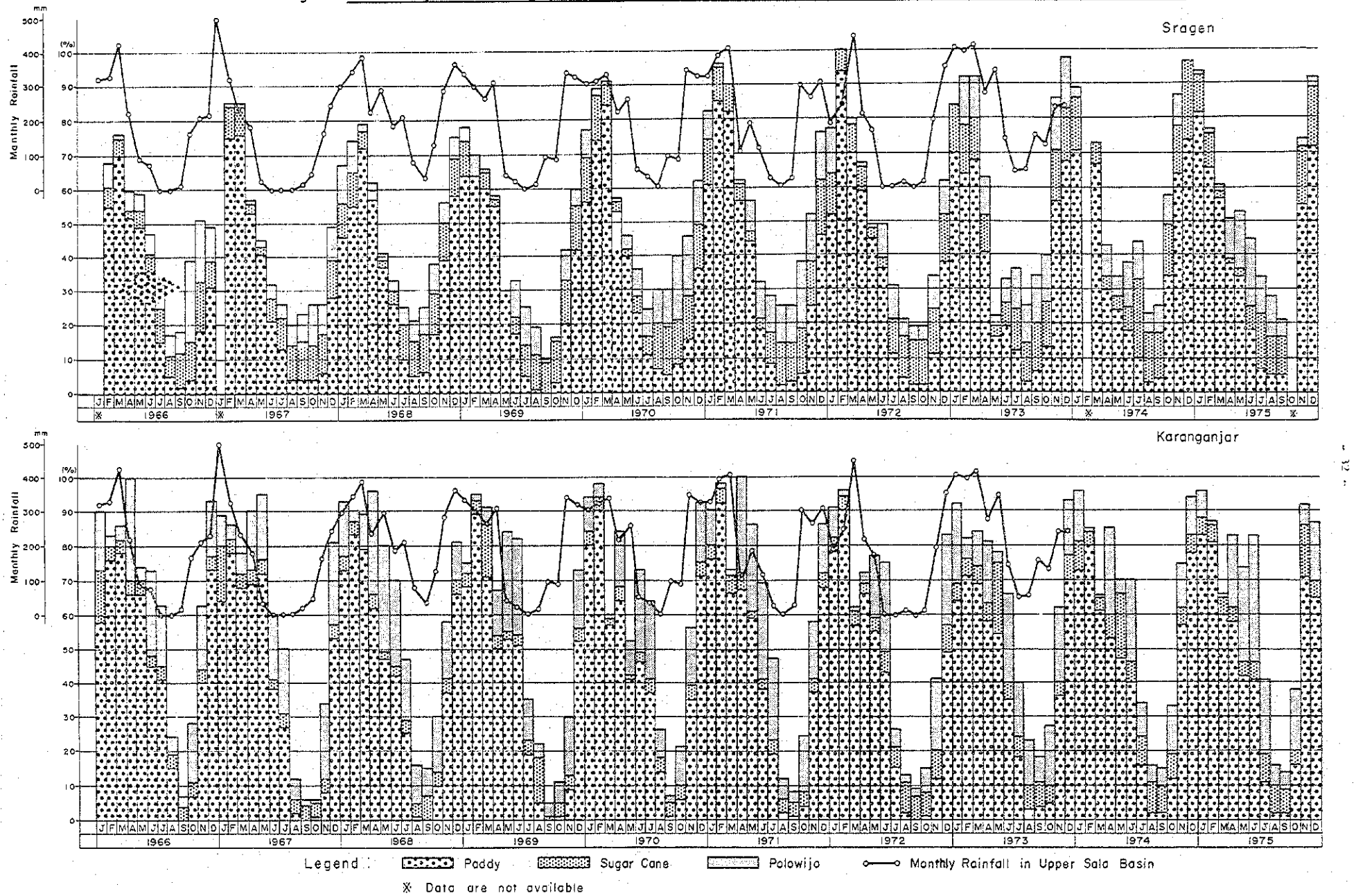


Fig.I-4 Monthly Percentage of Cropped Area in Technical and Semi-technical Irrigation Area



of February and the end of April. The dry season paddy is planted soon after the harvest of the wet season paddy and harvested in July. On about 900 ha in Dengkeng area, the planting period of wet season paddy is obliged to postpone until the beginning of April due to inundation.

In the project area, improved high yielding varieties such as IR-5, IR-8, IR-22, IR-24, IR-30, Pelita I, Pelita II, C4-63 have been widely spread over through the extension of BIMAS and INMAS program. IR-26 variety was newly introduced into the project area last year, because this variety is strong against leaf hopper damages. In addition to the above high yielding varieties, local varieties such as bengawan, Brandol, Cempo, Cemporandu, Srigunung have been applied in the project area. The growing period of paddy is usually about 115 to 135 days for the improved high yielding varieties and 150 to 170 days for the local varieties.

Fertilizer dosage in the project area is relatively high at present, ranging from 110 to 190 kg per ha and 40 to 65 kg of triple super phosphate per ha. Applicatim of agricultural chemicals is also well extended in the project area. The dosage is one to two liters per ha. The wet season paddy from 1975 to 1976 suffered serious damages caused by leaf hoppers or by grassy stunt virus through leaf hoppers, and more than four liters of insecticides were sprayed. Major agricultural chemicals used in the project area are diazinon, endrin, furadan and nogos.

Farming in the project area is labour intensive from the stage of seeding to harvest although animal power such as buffaloes or oxen is used for land preparation. "Ani-ani" system is the prevailing method of harvesting, which causes considerable field losses.

In spite of the relatively high dosage of chemical fertilizer and agricultural chemicals, the productivity is low as mentioned later because the application of fertilizer, and chemicals is not made appropriately in time and in volume. The farmers cannot get these materials at the right time or sometimes may not know the optimum fertilization period. Proper technics for the application and proper water management are also not made in the project area.

Sugar cane is cultivated only in the irrigated area under contract with PNP. Sugar cane is planted between early of March and the end of May and harvested between early May and the end of July in the next year.

The variety applied in the project area is mainly P.O.J., which is specified by PNP. Its growing period is 14 months. All the necessary inputs such as seed and fertilizer are provided by PNP and cultivation practice is also guided by PNP. On the very limited area, farmers grow sugar cane for their own consumption.

Polowijo crops are planted both in the dry season and the wet season, making use of soil moisture which remains after the wet season

paddy is harvested and precipitation at the onset of the wet season. Major crops are cassava, maize, peanut and soybean in the project area. Cassava and maize are cultivated as staple foods in a relatively wider area. The varieties used are Metro and Perta for maize, and Patangpuluhan, Bestak, Genderuwo, Kodok and Sawi for cassava. Soybean and peanut are introduced for getting cash income as well as providing protein food. The varieties used in the project area are local ones such as Ambang, Kedele laut and Kedele gendiar for soybean, gundul Teparo and Brol for peanut. Since no fertilizers and chemicals are used, the yield is generally low.

At present, farm inputs for each crop are estimated on the basis of the collected data which are presented in Table I-15.

2.7 AGRICULTURAL PRODUCTION

Production of major crops at present in the project area is estimated after reviewing the available data during the field survey, which include agricultural statistics in Indonesia and Central Java, collected data at PNP XVI and agricultural offices in Karesidan, Kubupaten up to Kecamatan and field spot survey data. Estimated unit production and total production of farm crops are presented in Table I-17.

As shown in the table, unit yields are generally low except for sugar cane; unit yield of paddy/1 is ranging between 2.0 t/ha and 3.8 t/ha depending on the land condition. Total production of paddy is about 83,600 tons, while about 168,000 tons of sugar cane is produced in the project area. As polowijo crops, about 500 tons of soybean, 300 tons of peanut, 1,500 tons of maize and 11,900 tons of cassava are produced.

Livestock and poultry raising is not a main line of the agricultural activity in the project area, but plays an important role in view of providing animal power for cultivation and protein food. Number of livestocks owned, the slaughtered and eggs produced in four Kabupatens which are wholly or partially coming under the project area are presented in Tables I-18 to I-20.

/1 In this report, the term "paddy" refers to "dry stalk paddy" unless otherwise mentioned. The rate of conversion from dry stalk paddy to milled rice is 52%.

Table I-16 Present Inputs for Each Crop

Kind of Crops	Seed (Kg/Ha)	Fertilizer Urea (Kg/Ha)	TSP (Kg/Ha)	Insecticide (l/Ha)	Labor (Man-day/Ha)
Irrigation Paddy	30	190	65	2	242 /1
Rainfed Paddy (Wet Season)	35	120	45	1	194 /1
Rainfed Paddy (Dry Season)	35	110	40	1	184 /1
Rainfed Paddy (Inundated)	35	120	45	1	194 /1
Sugar Cane	22,500 (stalkes)	400 (ZA)	150	-	554
Peanut	100	-	-	-	75
Soybean	35	-	-	-	64
Maize	25	50	-	-	45
Cassava	11,000 (stalkes)	-	-	-	65

Note: /1 Excludes animal power for land preparation and labor for harvesting.

Table I-17 Unit Yield at Present and Agricultural Products

Kind of Crops	Unit Yield (t/ha)	Cropping Area (ha)	Products
Paddy			
(Irrigated area)			
wet season	3.8	12,720	48,336
dry season	3.5	5,530	19,355
(Rainfed area)			
wet season	2.7	4,910	13,257
dry season	2.1	390	819
Inundated area	2.0	900	1,800
Sugar cane	92	1,830	168,360
Soybean	0.4	1,290	516
Peanuts	0.5	600	300
Maize	0.5	3,090	1,545
Cassava	3.3	3,600	11,880

Table I-18 Livestock and Poultry Holding in the Project Area

(Head)

	Horse	Cow	Buffalo	Sheep/Goat	Pig	Chicken	Duck
Sragen	205	17,067	7,204	35,034	3,292	209,281	18,593
Sukoharjo	190	16,808	9,844	38,526	2,203	218,428	20,398
Karanganyar	100	3,545	1,447	5,382	1,289	33,162	5,596
Klaten	74	904	3,781	7,371	71	112,729	70,562
Total	569	38,324	22,276	86,313	6,855	573,600	115,129

Source: Dinas Peternakan in four related Kabupatens

Table I-19 Livestock Slaughtered in the Project Area

(Head)

	Cow	Buffalo	Sheep/Goat	Pig	Chicken/Duck
Sragen	821	224	2,615	-	28,421
Sukoharjo	651	145	4,383	-	n.a.
Karanganyar	68	5	104	-	20,900
Klaten	-	334	856	-	10,183
Total	1,590	708	7,958	-	59,504

Source: Dinas Peternakan in four related Kabupatens.

Table I-20 Eggs Production

(1,000)

	Chicken	Duck	Total
Sragen	4,663	773	5,436
Sukoharjo	1,181	1,200	2,381
Karanganyar	554	492	1,046
Klaten	275	81	356
Total	6,673	2,546	9,219

Source: Dinal Peternakan in four related Kabupatens.

2.8 MARKETING

2.8.1 Distribution of Agricultural Inputs

There exist two distribution systems for farm inputs of paddy production in the project area. One is through BIMAS/INMAS program and the other is through local market.

Most of the necessary inputs for paddy production such as seed, fertilizers and chemicals are provided through cooperative (BUUD/KUD) at subsidized prices through BIMAS/INMAS programs. For BIMAS, credit for purchasing the required inputs is supplied by Bank Rakyat Indonesia (BRI) at the interest rate of one percent per month, while for INMAS, no credit is provided.

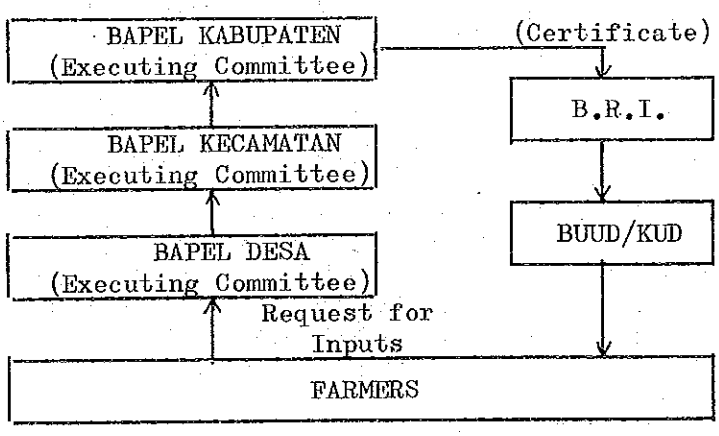
There are two types in BIMAS program, namely BIMAS Baru and BIMAS Biasa. Improved seeds are supplied by BIMAS Baru, while local varieties are provided by BIMAS Biasa. BIMAS package contains, in general, 25 kg of seed, 200 to 250 kg of urea, 75 kg of TSP, 2 ℓ of insecticide and 100 g of rodenticide, together with some living expenditure allowance.

The distribution system of farm inputs for paddy through BIMAS program is illustrated in Fig. I-5.

In the project area, BUUD/KUD was established in most of the irrigated areas and began functioning in connection with the national BIMAS/INMAS programs for increasing rice production (Details of the institutional framework are discussed in Study Report III, INSTITUTIONS). However, partly due to lack of transportation and storage facilities and partly due to unsatisfactory management, those inputs are often not distributed timely and enough in volume. Parts of the inputs required are, therefore, supplemented by the local market.

For sugar cane production, all inputs are supplied by PNP in the case of contract cultivation.

Fig. I-5 Distribution System of Input for Paddy (BIMAS, INMAS package)



2.8.2 Marketing of Output

(Rice)

Marketing of rice, which consists of purchase from farmers in very small quantity, storage, processing and sales to consumers is performed by Tebasan (middleman who purchases standing paddy in the field), middleman, rice miller and BUUD/KUD in the project area. General market flow of rice is summarized in Fig. I-6.

According to the farm survey, salable amount of rice is less than 40 percent of their products for an average farm size in the project area and the ratio of paddy distribution system on different land condition is as follows.

Table I-21 Ratio of Disposal of Paddy

	Tebasan	BUUD/KUD	Middleman	Rice mill	Local market
Irrig. area	-	6%	19%	17%	58%
Rainfed area	-	4%	50%	-	46%
Inundated area	77%	-	3%	4%	16%

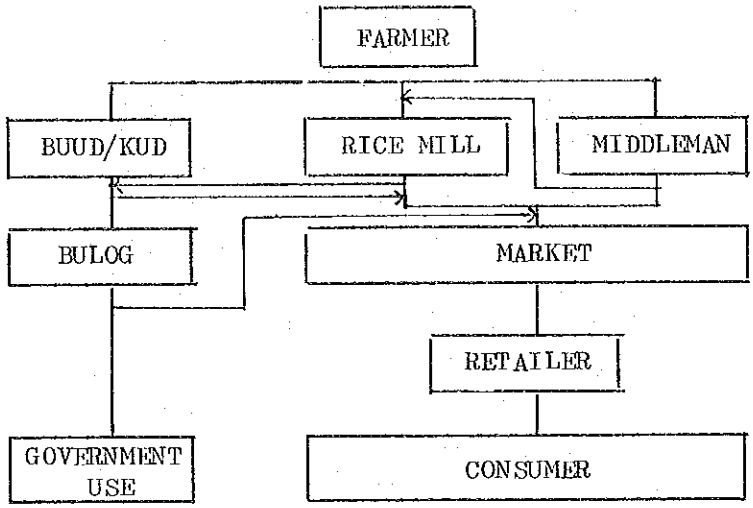
In the irrigated area, most of the output is brought to local market by farmers themselves as white rice. The price of rice is determined in the market, which fluctuates from season to season. The rice mill and middleman purchase relatively small part of their output in this area.

In the rainfed area and inundated area, where productivity of paddy is low under less favourable irrigation condition, more than half of their products sold are purchased by middleman or Tebasan in the form of wet stalk paddy or dry stalk paddy. In this case, bargaining power of the middleman affects the price favourably for the buyer.

As shown in the above table, the share of BUUD/KUD is very small in all areas. Severe qualification for purchasing paddy with relatively low price is the main reason for the limited share.

BUUD/KUD purchases rice mainly for BULOG which is a governmental organization established for stabilizing prices by purchasing rice at a floor price (Rp. 69.5/kg for dry grain) and sell it when market price goes up above a ceiling price (Rp. 125/kg for milled rice). However, because of still inadequate organization, insufficient staffing, and not enough storing capacity, the operation of BULOG is limited to control of rice imports and to supply to the military and Government employees.

Fig. I-6 Market Flow of Rice



(Sugar Cane)

As mentioned earlier, most of the sugar cane production in the project area is conducted under the contract with PNP-XVI. All the sugar cane produced is brought to PNP factory for processing.

There are five sugar factories in the related Kabupatens. Total processing capacity of these factories is about 8,100 tons of sugar cane per day at present, which will be expanded up to 11,100 tons per day in 1982. Processing capacity of each factory is presented in the following table.

Table I-22 Processing Capacity of Sugar Cane in Three Related Kabupatens

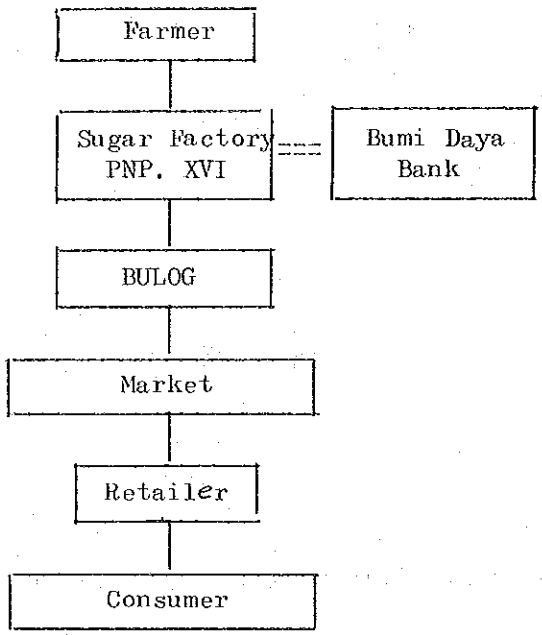
Kecamatan	At present (1976)	Future (1982)
Sragen		
Mojo	1,762 t/day	2,000
Karanganyar		
Tasikmadu	2,399	2,500
Colomadu	1,280	1,800
Klaten		
Ceper Baru	1,089	3,000
Gondang Baru	1,561	1,800
Total	8,091	11,100

Source: PNP XVI Office in Surakarta.
Note : Future capacity is estimated on the basis of rehabilitation plan (1978/1982).

Refined sugar is sold on the market through BULOG, which is a sole agent for sugar processed in PNP XVI. BULOG undertakes market operation for stabilizing the price of sugar as in the case of rice.

The market flow of sugar is illustrated in the following figure.

Fig. I-7 Market Flow of Sugar



(Polowijo)

Large part of peanut and soybean produced are sold to the market for gaining cash income, while polowijo crops such as maize and cassava are mainly consumed by farmers as supplemental staple foods.

Most of the polowijo crops harvested in the project area are distributed through middleman or brought to local market directly by farmers themselves.

Tebasan also plays an important role in the marketing of polowijo crops, who buys crops before harvesting with some advance payment and provides some credits for farmers.

2.9 FARM ECONOMY

Farm economy is investigated by the farm survey conducted during the field survey. On the basis of the results, farm budgets are prepared for a typical farmer holding 0.52 ha both in the irrigated area

and the rainfed area, as presented in Tables I-22 to I-24.

Comment on the farm economy is briefly made by each item as follows:

2.9.1 Farm Gross Income

Farm income

Farmers in the project area get their incomes mainly from farming activities. Particularly, paddy is the most important income source for the farmers both on the irrigated area and rainfed area. In the rainfed area, polowijo crops play an important role in gaining farm income and large part of the total farm income comes from that sales.

As explained in the preceding section, livestock raising is not a main line of agricultural activity in the project area. Incomes from the sales of livestock amount to 6% and 14% of the total farm income for the irrigated farmer and rainfed farmer, respectively.

Non-Farm income

In addition to the farm income, farmers get their income from non-farm activities such as Sewa (lending land), off-farm labor, trade and others. This non-farm income accounts for about 10 to 20% of gross income for the average farmer in the project area.

As shown in the tables mentioned above, farmers in the rainfed area depend more on non-farm income than farmers in the irrigated area.

According to the farm survey, as cultivated area increases, the income from land rent increases, while the income from labor and trade increases as the cultivated land decreases.

2.9.2 Farm Gross Outgo

Farming expenses

Farming expenses consist of two items, namely, the cost of materials such as seeds, fertilizers and chemicals, and the labor cost. The cost of materials accounts for about 40% of the total farm expenses for paddy production both in the irrigated area and rainfed area.

Since fertilizer dosage is already extended relatively well in the project area, the cost of it amounts to 70 - 80% of the total material cost.

With respect to labor cost, relatively large number of hired labor is employed for paddy production, while most of the field work is carried out by own labor for polowijo production. Most of the hired labor requirement for paddy production occurs at the stage of land preparation and harvest. The land preparation is done by animal power even on the smallest farm and the harvest is conducted by "ani-ani".

In total, farming expenses are about 40% of the farm income for the average farmer both in the irrigated area and the rainfed area.

Farm investment and financial status

From the farm survey, it is estimated that about 80% of farm investment is directed to livestock, while the remaining 20% to farm equipment. Total farm investment is not large, ranging from Rp. 13,000 to Rp. 40,000 per year.

Most of the investments are financed by farmers themselves partly supplemented by local organizations such as BUUD/KUD.

Apart from these investment relatively large amount of money is required for purchasing farm inputs for paddy production. Such cost is financed by BIMAS credit for BIMAS farmers at low interest rate of one percent per month, which is repaid after the harvest of the crop.

From the farm survey, outstanding debt for other purposes like living expenses is considered to be negligible in the project area.

Living expenses

In the calculation of living expenses, family consumption of the self-produced products are costed at current prices and included in the food consumption of the farm budget.

High ratio of food expenditure to total living expenditure is a characteristic of the consumption pattern in the project area, which amounts to about 60% of the total food expenses.

Other expenses are for daily consumption goods such as clothes, light oil and tobacco and for education and health, which have been increasing and reaches considerable amounts for the large size farmers.

2.9.3 Net Reserve

Net reserves of an average farmer are negligibly small as shown in the typical farm budget. This indicates that the agricultural productivity in the project area is relatively low and the farm economy is on the subsistence level.

Table I-23 Typical Farm Budget with Paddy Field of 0.52 Ha (Irrigated Area, at Present)

	Area (ha)	Unit yield (t/ha)	Total yield (t)	Unit price (Rp/kg)	Total value (Rp)
I. Gross Income					
1. Farm income					
Wet/s paddy	0.52	3.8	1.98	45	89,100
Dry/s paddy	0.22	3.5	0.77	45	34,650
Polowijo	0.18	-	-	-	10,910
Livestock	-	-	-	-	8,100
Sub-total	-	-	-	-	142,760
2. Non-farm income					
Wage income & trade					6,710
Others					15,650
Sub-total					22,360
Total Gross Income					165,120

	Area (ha)	Unit amount (kg/ha)	Total amout (kg)	Unit price (Rp/kg)	Total cost (Rp)
II. Gross Outgo					
1. Farming Expenses					
(Paddy)					
Seed	0.74	30	22.2	125	2,775
Fertilizer/1	0.74	255	188.7	80	15,096
Chemicals	0.74	2	1.48	900	1,332
Labor cost					26,760
(Polowijo)					
Seed	0.18				1,510
Labor cost					900
Land tax	0.52 Ha				2,080
Interest on investment					4,770
Livestock					2,670
Sub-total					57,893
2. Living Expenses					
Food consumption					63,150
Other living expenses					42,100
Sub-total					105,250
Total Outgo					163,143
III. Net Reserve (or capacity to pay)					1,977

/1 Urea + TSP

Table I-24 Typical Farm Budget with Paddy Field of 0.52 Ha (Rainfed Area, at Present)

	Area (ha)	Unit yield (t/ha)	Total yield (t)	Unit price (Rp/kg)	Total value (Rp)
I. Gross Income					
1. Farm income					
Wet/s paddy	0.52	2.7	1.4	45	63,000
Polowijo	0.44				26,660
Livestock					14,090
Sub-total					103,750
2. Non-farm Income					
Wage income & trade					7,980
Others					18,630
Sub-total					26,610
Total Gross Income					130,360

	Area (ha)	Unit amount (kg/ha)	Total amount (kg)	Unit price (Rp/kg)	Total cost (Rp)
II. Gross Outgo					
1. Farming Expenses					
(Paddy)					
Seed	0.52	35	18.2	125	2,275
Fertilizer /1	0.52	165	85.8	80	6,864
Chemicals	0.52	1 //	0.52 //	900	468
Labor cost	0.52				14,630
(Polowigo)					
Seed	0.44				3,690
Labor cost	0.44				2,520
Land tax	0.52				1,560
Interest on investiment					3,860
Livestock					4,230
Sub-total					40,097
2. Living Expenses					
Food consumption					58,020
Other living expenses					32,230
Sub-total					90,250
Total Outgo					130,347
III. Net Reserve (or capacity to pay)					13

/1 Urea + TSP

3. AGRICULTURAL DEVELOPMENT PLAN

3.1 GENERAL

As explained in the preceding chapters, production of food-stuff is still insufficient to meet the domestic demand which is increasing in proportion to the population growth and per-capita income increase. In the project area, there exist many constraints for agricultural development such as small farm size, high population density with limited employment opportunity and difficulty in developing new cultivation land.

For eliminating these constraints and facilitating food production increase, agricultural development plan is formulated for the irrigable area of 23,200 ha, considering that only the introduction of intensive farming by construction of irrigation facilities as well as the Wonogiri dam can solve the facing problems.

The Wonogiri dam is now in the stage of detailed design. The active storage capacity of the dam is 440 million m^3, out of this an actual capacity of reservoir usable for irrigation is 400 m^3/1. In the formulation of the development plan, maximum utilization of the available water from the Wonogiri Dam is fully taken into account.

In the development plan, present farming dependent on rainfall will be changed into year-round irrigation farming with the completion of irrigation system, and the most intensive use of farm land for paddy production will be introduced. The productivity of agricultural production is expected to increase to the level of 5.5 t/ha from the present low level. Total production of paddy will rise to about 273,000 tons, approximately 3 times of the present production of about 84,000 tons.

3.2 LAND USE

With the introduction of year-round irrigation farming by the construction of irrigation facilities and the dam, land use is expected to change considerably.

As the project area is already developed for crop production, no additional land will be reclaimed. However, the entire project area (23,200 ha) will be turned into technical irrigation area on which intensive land use will be made possible.

/1 Active storage capacity (440 million m^3) consists of pondage loss (10 million m^3) at Colo weir, river maintenance flow (30 million m^3) and irrigation water (400 million m^3).

Predominant crop in the project area will continue to be paddy, but its cultivation method is expected to become much more intensive. The ratio of paddy planting area to the total area will reach about 90 %.

Cultivation area of sugar cane is also expected to increase from the present 1,800 ha to 2,100 ha/1 in view of the capacity of sugar factories in the area and the relative profitability of its production.

Polowijo crops will not be cultivated in the project area since all the cultivation area will be changed into more profitable use for paddy and sugar cane production. The balance of the reduced supply and the demand in the region will be met by the supply from outside the project area where polowijo crops are intensively planted particularly on uplands.

The land use expected in future with the irrigation project is presented in the following table. Multi-cropping index will increase to 2.23 as shown in the same table.

Table I-25 Future Land Use

(ha)

	Sragen area	Karanganyar area	Dengkeng area	Total
Paddy Field				
Paddy	22,850	17,750	9,000	49,600
Sugar cane	1,500	600	-	2,100
Total	24,350	18,350	9,000	51,700
Multi-cropping index				2.23/2

3.3 PROPOSED CROPPING PATTERN

3.3.1 Selection of Crops

Prior to selecting the most optimum cropping pattern in the future, selection of crops to be planted is made in due consideration of the demand supply condition and profitability.

On the basis of these criteria, paddy and sugar cane are chosen as the most optimum crop for the Wonogiri irrigation project. Particularly, paddy is selected as the main crop from the following reasons.

/1 From the past trend of sugar cultivation area during 1966-1975, it is estimated that sugar cane area will increase by 50 ha per annum unit will reach 2,100 ha in or around 1980 and stay at the level afterward.

/2 51,700 ha/23,200 ha

1) Self-sufficiency in national economy

In 1974, about 1.1 million tons of rice was still imported and US$374 million of foreign exchange was spent for it. This fact indicates that further increase in rice production is urgently required not only for meeting the growing domestic demand for foodstuff but also for saving the scarce foreign exchange.

2) Regional demand supply condition

Although rice production in Central Java has attained relatively well from 1970, per-capita production of rice is 100-110 kg, still short of desirable volume and the shortage is supplemented by imported rice and polowijo crops such as maize, cassava and sweet potato.

3) Profitability of rice with relatively stable price

High profitability of rice production is proved by crop benefit cost evaluation which is presented late in this section. It is also confirmed through farmers interview that they have sufficient incentives to produce paddy as much as possible with enough irrigation water.

3.3.2 Cropping Pattern

For determining the most optimum cropping pattern, three alternative cropping patterns have been formulated. The most intensive cropping pattern is selected after the study of water balance between irrigation requirement and available water resources, and cost benefit comparison.

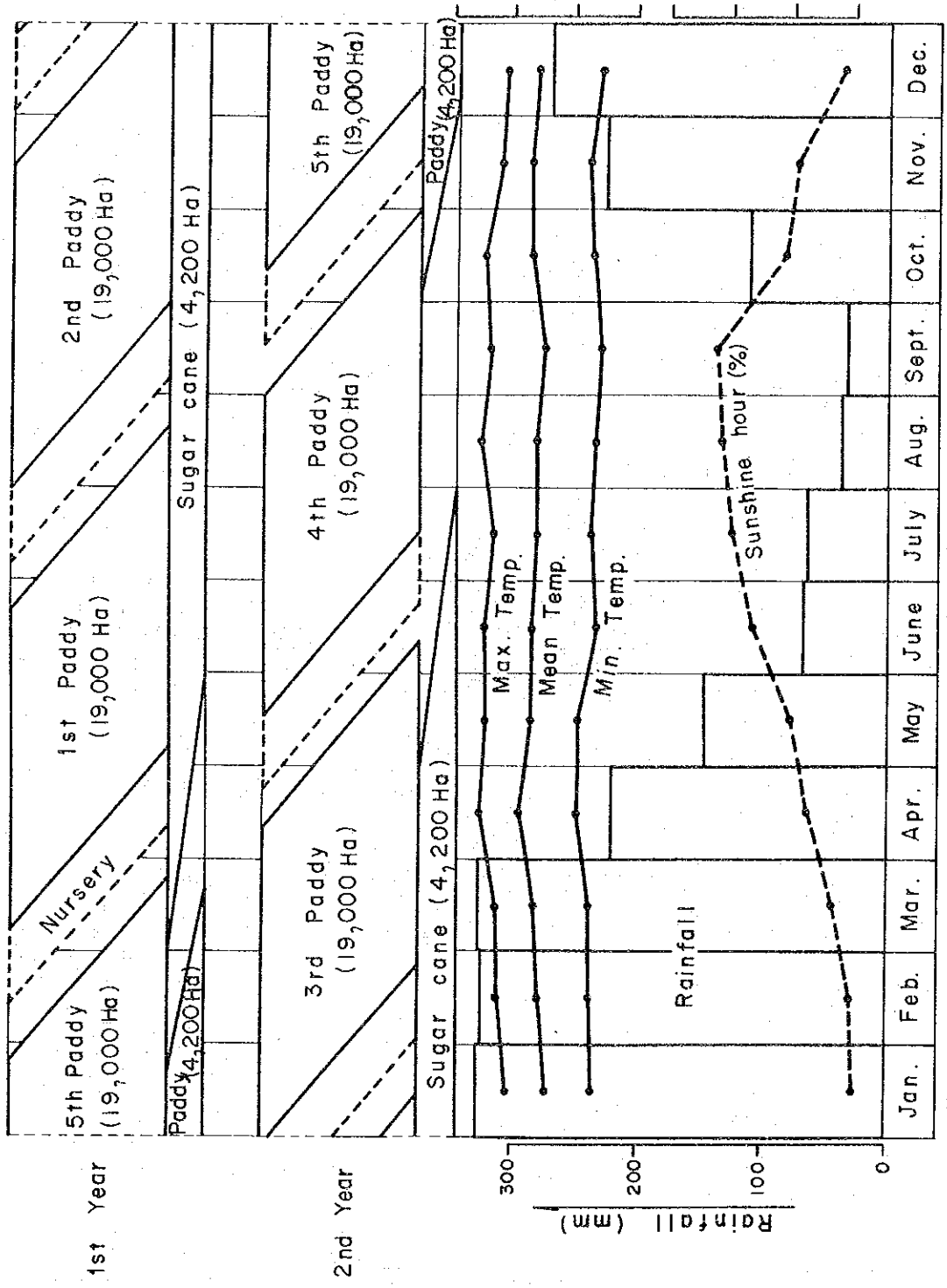
As shown in Fig. I-8, the proposed cropping pattern is an intensive one for paddy with five paddy crops in two years. Agronomical considerations for introducing such an intensive cropping pattern are explained below.

Since there is no limiting factor for germination due to high temperature throughout a year, seedling of paddy can be done at any time in the project area. Important factor for attaining high yield of paddy is how to increase the photosynthetic efficiency of the rice plant.

Critical growth periods in terms of sunlight requirement are about 15 days just before heading and about 25 days just after heading. The rice plant should, therefore, get sunny weather during these periods. According to the sunshine hour data, sunshine hour ranges from 30% to 50% in the wet season and from 50% to 75% in the dry season, respectively. Cropping pattern of paddy is prepared as to receive sunny weather as much as possible.

In general, rice plant requires a large amount of water for consumptive use. In due consideration of economical water use, early to medium maturing, high yielding varieties such as IR-26 will be introduced into the project area.

Fig. I-8 Proposed Cropping Pattern



In the intensive cropping pattern, fallow period from harvesting to next seeding will be about 16 days. However, only one twenty fifth of the paddy field will be occupied by the nursery bed while the residual 24/25 of the paddy field remain as fallow for about 41 days from the harvest to the next transplanting. Therefore, there are no difficulties to introduce intensive one from the view point of farm operation. Actually, this intensive pattern is prevailing in the well irrigated land in Klaten adjacent to the project area. This fact suggests that this cropping pattern will extend over the project area if enough irrigation water is made available.

3.4 ANTICIPATED YIELD AND FARMING PRACTICE

3.4.1 Expected Unit Yield in the Future

Unit yields of farm crops are estimated both for future without-project condition and future with-project condition.

After reviewing the historical production data in Central Java and the related Kabupaten and checking the results of the recent field survey, it is assumed that there will be no substantial increase in unit yield of agricultural production in the project area under the present farming conditions.

However, the productivity of paddy is expected to increase slightly through extensive use of inputs and expansion of improved farming technics including additional inputs dosage without any improvement of the infrastructures.

Unit yields of paddy in future without-project condition are estimated taking into account the past trend of the productivity in Central Java and assumed inputs increase.

Under the condition with project, it is expected that unit yield of farm crops will increase considerably. The expected unit yield of paddy and sugar cane be 5.5 t/ha, and 120 t/ha respectively which is estimated on the basis of the recent experimental data in the project area, in the experimental station in Bogor and in the International Rice Research Institute and the results of the well irrigated area adjacent to the project area (Refer to Annex 1 of this Chapter).

For the achievement of the anticipated yield, optimum application of farm inputs such as fertilizer, chemicals are required together with effective water management and operation of the irrigation system.

The yield will increase gradually from the present level and will attain the target yield in the 7th year after completion of the irrigation facilities. The future unit yields of various crops both for without and with project conditions are summarized in Table I-26.

3.4.2 Farming Practices and Farm Inputs

Proper irrigation farming is the most essential factor for realizing full exploitation of the agricultural potentiality in the project area; its practices to be introduced in the project area are as follows.

Paddy

Variety and nurserying

An early to medium, high yielding varieties such as IR series will be introduced. Out of IR-series, IR-26 variety is recommendable. This variety gives vigorous seedlings, erect leaves and high tillering capacity. Furthermore, this has strong resistance to leaf hoppers and grassy stunt virus carried by them. Its growing period ranges between 125 and 130 days. The design growing period is taken as 130 days including nursery period of 25 days. The area of the nursery bed is 400 m^2 per ha or 1/25 of paddy field. Amount of paddy seed required is 25 kg per ha. The design value of fertilizer application on the nursery bed is 12.5 g of urea and 12.5 g of triple super phosphate per m^2 or 5 kg each per ha.

Land preparation and transplanting

Land preparation before transplanting will consist of 2 times of ploughings and 2 times of hallowings. These works will be done by using draft animals. Transplanting is carried out mainly by female power. The planting density is 30 cm x 15 cm. Seedling is planted in shallow depth (3 cm from surface) and density per hill is three.

Fertilization in the paddy field

Design values of fertilizer per ha of the paddy field is 245 kg of urea and 95 kg of triple super phosphate.

Because of high soil temperature in the project area, rooting activity of rice is so rampant. Hence, the growth of paddy in early and medium stages is vigorous but trends to become dissipated in the later growing stages. Consequently, it is very effective for an increase of paddy production to give heavy top-dressing of urea in the late period of a young panicle formation stage. The application schedule of urea is shown below:

Basic-dressing (transplanting time)	25% urea
First top-dressing (about 2 weeks after transplanting time)	25% urea
Second top-dressing (18 - 20 days before heading)	50% urea

Total amount of triple super phosphate will be applied as basic dressing.

Weeding and application of chemicals

Weeding will be done at two times, namely, at about 25th and 50th day after transplanting. Main insect in the project area is rice-borer. Rat-damages, which are not serious at present, will be considered after the project will be put in operation. Design value of chemicals per ha is 4 ℓ of diazinon or endrin as insecticide and 200 g of zone-phosphide as rodenticide.

Water control

Water requirement of paddy is different corresponding to its growing stages. Therefore proper water control is essential for irrigation farming. Water control shown below will be desirable.

Transplanting-rooting	Deep water depth
Most tillering period	Shallow water depth with intermittent irrigation
Neck-node differentiation period upto panicle formation period	Drying practice
Panicle formation period upto full ripening period	Shallow water depth with intermittent irrigation
Full ripening period to harvest	Water drained

Harvesting

Harvesting will be done mainly by female power with ani-ani equipment.

It is expected, on the other hand, that there will be no substantial change in inputs requirement for future without project condition except some increase in fertilizer input.

Inputs requirement for each crop in the future without and with-project conditions is summarized in Table I-27 to I-28.

3.5 FARM CROP PRODUCTION

Total production of the farm crops is estimated by multiplying the anticipated unit yield with the future cultivation area both for future without-project and with-project conditions. In case of future without-project, the land use is assumed to remain the same as the present one since no substantial improvement for the infrastructures will be made.

Production of paddy will increase to 272,800 tons, or more than three times of the expected production on without-project condition. Sugar cane production is also expected to grow to the level of 252,000 tons from the present level of 168,000 tons.

The crop production estimated both for future without-project and with-project conditions is summarized in Table I-29.

Table I-26 Future Unit Yield of Crops

	Kind of crops	Without project	With project
1)	Paddy		
	Irrigated area		
	wet season	4.0	5.5
	dry season	3.7	5.5
	Rainfed area		
	wet season	2.8	-
	dry season	2.2	-
	Inundated (wet season)	2.0	-
2)	Sugar cane	92	120
3)	Soybean	0.4	-
4)	Peanut	0.5	-
5)	Maize	0.5	-
6)	Cassava	3.3	-

Table I-27 Inputs Requirement per Ha in Future Without-Project

Kind of crops	Seed (kg)	Fertilizer Urea, (kg)	Fertilizer TSP (kg)	Insecticide (ℓ)	Labor (manday/ha)
Irrigated paddy	30	200	70	2	242/1
Rainfed paddy (wet season)	35	130	50	1	194/1
Rainfed paddy (dry season)	35	120	45	1	184/1
Rainfed paddy (inundated)	35	120	45	1	194/1
Sugar cane	22,500 (stalks)	400 (ZA)/2	150	-	554
Soybean	35	-	-	-	64
Peanut	100	-	-	-	75
Maize	25	50	-	-	45
Cassava	11,000 (stalks)	-	-	-	65

/1 Excluding animal power for land preparation and labor for harvesting.

/2 Ammonium sulphate.

Table I-28 Inputs Requirement per Ha in Future With-Project

Kind of crops	Seed (kg)	Fertilizer Urea, (kg)	Fertilizer TSP (kg)	Insecticide (ℓ)	Labor (manday/ha)
Irrigated paddy	25	250	100	4 (plus rodenticide 200 g)	254/1
Sugar cane	22,500 stalks	600 (ZA)	200	4 (plus fungicide 2 ℓ)	600

/1 Excluding animal power for land preparation and labor for harvesting.

Table I-29 Future Crop Production

(tons)

Kind of crops	Without Project (A)	With Project (B)	Increment (B) - (A)
1) Paddy			
Irrigated area			
wet season	50,880)	272,800	201,459
dry season	20,461)		
Rainfed area			
wet season	13,748	-	-13,748
dry season	858	-	-858
Inundated	1,800	-	-1,800
Sub-total	(87,747)	(272,800)	(185,053)
2) Sugar cane	168,360	252,000	83,640
3) Soybean	516	-	-516
4) Peanuts	300	-	-300
5) Maize	1,545	-	-1,545
6) Cassava	11,880	-	-11,880

3.6 MARKETING AND PRICE PROSPECTS

3.6.1 Demand and Supply Conditions for Farm Crops

Rice

As explained in the preceding chapter, domestic rice production is still insufficient for feeding the population, and Indonesia has been importing more than one million ton of rice each year since 1973.

Under such situation, an increase in rice production is strongly emphasized and its strategic development plan is set out in Pelita II.

(Production Forecast)

In Pelita II, rice production is expected to increase to about 18.2 million tons in 1978, with an annual growth rate of 4.5%.

Taking into account the past trends of rice production-increase and the target set under Pelita II, the forecasting of future rice production is made on each of the following four (4) assumptions, in order to estimate demand-supply conditions of rice in each case:

Forecast A: Rice production will increase by relatively low rate of 2% per annum after 1973.

Forecast B: Rice production will increase by 3% per annum after 1973.

Forecast C: Rice production will increase by 4% per annum after 1973.

Forecast D: Rice production will increase by relatively high rate of 4.5% per annum after 1978 and production plan of Pelita II will be materialized until 1978.

For each case, the anticipated production is calculated for the period from 1974 until 1990 and the results are presented in Table I-30.

Rice production in 1990, as expected in Forecasts A, B, and C, will be 20.5 million tons, 24.1 million tons, and 28.5 million tons, respectively, while in Forecast D, it will be 30.8 million tons.

(Demand Forecast)

Future demand for rice is estimated taking into account the two factors, namely, forecast population and expected per-capita requirement of rice.

Future population is estimated by the Central Bureau of Statistics of the Government of Indonesia assuming that the annual increase rate will be about 2.3% and the forecast is presented in Table I-31. Total population is forecasted at 186.4 million in 1990.

Annual per-capita consumption of rice in the future is estimated on the basis of the present per-capita consumption and income elasticity of the demand./1 Price elasticity of the demand is not taken into account for the estimate assuming that the relative price between rice and other goods will be constant during the forecast period.

Present per-capita consumption of rice is firstly estimated at about 125 kg in 1974. Assuming that the per-capita income increases at an annual rate of 5% and the income elasticity of the demand is 0.25, annual per-capita consumption of rice is calculated for the period of 1974 to 1990.

Using these estimated figures, the expected future demand for rice is calculated in two cases by multiplying the population forecasted by the estimated per-capita consumption. The results are presented in Table I-32.

(Market Prospect)

On the basis of the production forecast and the demand forecast, market prospect of rice is briefly projected in Table I-32.

In Case I, (per-capita consumption of rice is assumed to increase in proportion to income increase), it is indicated that the domestic production of rice is still less than the expected domestic consumption until 1981 in all production forecasts except D, that means import of rice will be required continuously even though the production increases at an annual rate of 4.5%. It is also expected that the domestic production can meet the domestic demand from 1987 for C in which the annual increase of production is assumed at a relatively high rate of 4.0%. Domestic supply cannot satisfy the demand except C and D by 1990 and the difference between the demand and the supply will increase to 7.5 million tons and 3.8 million tons for A and B, respectively.

Even in Case II (per-capita consumption of rice in the future is assumed to remain at the same level of 125 kg until 1990, which would be rather optimistic forecast excluding the factor of income elasticity), it is projected that the supply shortage of rice will continue if the production increase is less than 3% per annum.

Although the market prospect is analyzed on the basis of the simple assumptions and comparison, it suggests that the supply shortage can continu in the future for all cases if the increase rate of production is less than 3% per annum and an annual

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/1 0.25 is applied for the income elasticity referring to "Price Forecast for Major Primary Commodities" prepared by IBRD.

Production increase of 4% seems to be a conservative target for attaining self-sufficiency around 1990. The annual increase rate of 4% would be a rather strategic target in view of its historical trend.

In view of this expected demand supply condition of the national level, the anticipated increase in rice production of about 0.1 million tons (0.2 million tons in dry stalk paddy) through the implementation of the irrigation project will be able to find outlets in the domestic market.

Sugar

At present, the domestic production of sugar is not sufficient for the national requirement and the has been supplemented by import.

To cope with the situation, a strategic plan has been set out under Pelita II for the purpose of increasing the production at an annual rate of 5.6%.

Although the target seems rather ambitious, per-capita production will still be 9.6 kg in 1978, which is considerably below the average per-capita consumption of about 15 kg in the Republic of China.

The consumption of sugar is expected to increase in the future in proportion to the population increase and income increase. Domestic demand for sugar in Indonesia is estimated at 1.6 million tons around 1980 on the basis of the estimated population and income increase. The sugar production to be increased will not be able to meet this expected demand around 1980 and it is anticipated to take relatively long time for Indonesia to export sugar after satisfying the domestic requirement. It is, therefore, projected that the production increase of sugar through the implementation of the project will therefore find an easy outlet in the domestic market.

Table I-30 Production Forecast of Rice

(10^3 ton)

	Forecast A	Forecast B	Forecast C	Forecast D
1974	14,899	15,045	15,191	15,032
1975	15,191	15,483	15,790	15,633
1976	15,498	15,951	16,418	16,383
1977	15,775	16,433	17,075	17,235
1978	16,126	16,929	17,762	18,183
1979	16,447	17,440	18,478	19,001
1980	16,769	17,966	19,222	19,856
1981	17,105	18,492	19,982	20,747
1982	17,455	19,047	20,785	21,692
1983	17,805	19,632	21,618	22,656
1984	18,156	20,216	22,480	23,674
1985	18,521	20,815	23,386	24,747
1986	18,886	21,443	24,320	25,856
1987	19,266	22,086	25,285	27,020
1988	19,646	22,758	26,292	28,238
1989	20,040	23,430	27,344	29,511
1990	20,450	24,142	28,454	30,838

Forecast A: Annual increase ratio is assumed at 2% after 1973.

Forecast B: Annual increase ratio is assumed at 3% after 1973.

Forecast C: Annual increase ratio is assumed at 4% after 1973.

Forecast D: Annual increase ratio is assumed at 4.5% after 1973 and the figures for 1974 to 1978 are anticipated production under Pelita II.

Table I-31 Estimated Demand for Rice

	Population (10^3)	Case I (10^3 ton)	Case II (10^3 ton)
1974	129,083	16,135	16,135
1975	132,110	16,646	16,514
1976	135,190	17,304	16,899
1977	138,342	17,846	17,293
1978	141,579	18,547	17,697
1979	144,912	19,128	18,114
1980	148,349	19,879	18,544
1981	151,895	20,506	18,987
1982	155,389	21,288	19,424
1983	158,619	22,048	19,827
1984	162,619	22,767	20,327
1985	166,359	23,622	20,795
1986	170,185	24,336	21,273
1987	174,099	25,244	21,762
1988	178,103	26,181	22,263
1989	182,199	27,148	22,775
1990	186,390	27,959	23,299

Case I : Per-capita consumption of rice will increase annually assuming that increase of per-capita income is 5% per annum and income elasticity of the demand is 0.25.

Case II : Per-capita consumption of rice is assumed at 125kg.

Table I-32 Market Prospect of Rice

(Production Forecast - Total Demand)

(1) Case I

(10^3 ton)

	Forecast A	Forecast B	Forecast C	Forecast D
1974	-1,236	-1,090	-944	-1,103
1975	-1,455	-1,163	-856	-1,013
1976	-1,806	-1,353	-886	-921
1977	-2,071	-1,413	-771	-611
1978	-2,421	-1,618	-785	-364
1979	-2,681	-1,688	-650	-127
1980	-3,110	-1,913	-657	-23
1981	-3,401	-2,014	-524	241
1982	-3,833	-2,241	-503	404
1983	-4,243	-2,416	-430	608
1984	-4,611	-2,551	-287	907
1985	-5,101	-2,807	-236	1,125
1986	-5,450	-2,893	-16	1,520
1987	-5,978	-3,158	17	1,776
1988	-6,535	-3,423	111	2,057
1989	-7,108	-3,718	196	2,363
1990	-7,509	-3,817	495	2,879

(2) Case II

(10^3 ton)

	Forecast A	Forecast B	Forecast C	Forecast D
1974	-1,236	-1,090	-949	-1,103
1975	-1,323	-1,031	-724	-881
1976	-1,401	-948	-481	-516
1977	-1,518	-860	-218	-58
1978	-1,571	-768	65	486
1979	-1,667	-674	364	887
1980	-1,775	-578	678	1,312
1981	-1,882	-495	995	1,760
1982	-1,969	-377	1,356	2,263
1983	-2,022	-195	1,791	2,829
1984	-2,171	-111	2,153	3,347
1985	-2,274	20	2,591	3,952
1986	-2,387	170	3,047	4,583
1987	-2,496	324	3,523	5,258
1988	-2,617	495	4,029	5,975
1989	-2,735	655	4,569	6,736
1990	-2,849	843	5,155	7,539

Table I-33 Production Target of Sugar under Pelita II

	Production (10^3 ton)	Per-capita Production (kg)
1974	1,089	8.4
1975	1,194	9.0
1976	1,236	9.1
1977	1,319	9.5
1978	1,356	9.6

3.6.2 Price Prospect of Farm Products

Prices of the farm products in the future are estimated for evaluating the expected irrigation benefit and farm budget both economically and financially.

Economic Price

Economic farm gate price is estimated on the basis of the projected international market price/1 taking into account the transportation cost, processing cost and other expenses. The details of the calculation are presented in Table I-35 and the results are summarized in Table I-34.

Financial Price

Financial prices of farm products at farm gate are estimated on the basis of the actual prices which are prevailing in the local market. As explained in the preceding chapter, price of farm products fluctuates up and down from the harvest season to the next harvest season. With due consideration of the fluctuation, the monthly averages of the local market prices during past three years in the project area are conservatively applied for determination of the financial price in the future. The results of the forecast are presented below, while details of the estimate are given in Table I-36.

/1 The international price forecasted by IBRD for the period of 1980 to 1985 is applied.

Table I-34 Economic and Financial Price of Farm Products

(Rp)

	Econ. Price	Fin. Price
Paddy	59,000	45,000
Sugar cane	6,000	13,390
Peanut	95,000	207,000
Soybean	69,000	139,000
Maize	28,000	47,000
Cassava	13,000	18,000

Table I-35 Estimate of Economic Price

(1) Paddy (For import substitution)

a)	International market price/1 FOB Bangkok	Rp. 112,050/ton (eq. US$270/ton)
b)	Transportation cost (Bangkok - Surabaya)	Rp. 5,395 (eq. US$ 13)
c)	Handling charge & warehouse cost	Rp. 3,030
d)	Transportation cost (Surabaya - Solo)	Rp. 1,500
	Selling price of rice at ex - mill gate	Rp. 121,975
	Selling price of paddy (Value of 1-ton dry stalk paddy) Rp. 121,975 x 0.52	Rp. 63,427
e)	Milling charge	- Rp. 4,000
f)	Transportation cost	- Rp. 200
	Farm gate price	Rp. 59,227
		(≒ Rp. 59,000)

/1 Forecast price of rice during 1980 - 1985 by IBRD.

(2) Sugar cane (For import substitution)

a)	International market price of sugar /1 ISA Daily price FOB	Rp. 82,170 (eq. US$198)
b)	Handling & warehouse charge	Rp. 3,030
c)	Transportation cost (Surabaya - Solo)	Rp. 2,100
	Ex-factory price of sugar at Solo	Rp. 87,300
d)	Processing cost & OH cost of factory (30% of the Ex-factory price)	- Rp. 26,190
		(Rp. 61,110)
e)	Value of sugar cane (11%)	Rp. 6,722
f)	Transportation cost (Sugar factory - farm gate)	- Rp. 200
	Farm gate price	Rp. 6,522
		(≒ Rp. 6,000)

/1 Forecast price of sugar during 1980 - 1985 by IBRD.

(3) Soybean (Fore export)

a)	International market price /1	Rp. 87,980 (eq. US$212)
b)	Transportation cost (Surabaya - Japan)	- Rp. 6,225
c)	Handling and warehouse charge	- Rp. 3,030
d)	Transportation cost (Surabaya - Solo)	- Rp. 1,500
	Market price at Solo	Rp. 77,225
e)	Marketing cost (10% of the market price)	- Rp. 7,722
	Farm gate price	Rp. 69,503
		(≒ Rp. 69,000)

/1 Forecast price of soybean during 1980 - 1985 by IBRD.

(4) Peanut (Groundnut)
(For export)

a)	International market price/1	Rp. 117,030 (eq. US$282/ton)
b)	Transportation cost (Surabaya - Japan)	- Rp. 6,225
c)	Handling & warehouse charge	- Rp. 3,030
d)	Transportation cost (Surabaya - Solo)	- Rp. 1,500
	Marketing price at Solo	Rp. 106,275
e)	Marketing cost (10% of the market price)	Rp. 10,627
Farm gate price		Rp. 95,648
		(≒ Rp. 95,000)

/1 Forecast price of peanuts during 1980 - 1985 by IBRD.

(5) Maize (For export)

a)	International market price/1	Rp. 38,595 (eq. US$93/ton)
b)	Handling & warehouse charge	- Rp. 5,395
c)	Transportation cost (Surabaya - Solo)	- Rp. 1,500
	Market price at Solo	Rp. 31,700
d)	Marketing cost (10% of the market price)	- Rp. 3,170
Farm gate price		Rp. 28,530
		(≒ Rp. 28,000)

/1 Forecast price of maize duging 1980 - 1985 by IBRD.

(6) Cassava

Since international market price is not available for cassava, economic farm gate price is estimated on the basis of the average of the local market, taking into account the trend of the world price from 1973 - 1974 to 1980 - 1985.

Table I-36 Estimate of Financial Price

(Average of Semi-annual)

(Rp/Kg)

Crops	Market	1973		1974		1975		Av. of 73-75
		Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec	
Dry Stalk Paddy	Sukoharjo	35.1	42.0	40.6	42.9	43.9	69.3	
	Sragen	33.3	40.0	n.a.	50.0	45.0	61.4	
	Av.	34.2	41.0	40.6	46.5	44.6	65.4	45.4
Milled Rice	Sukoharjo	74.0	84.1	84.9	91.3	82.5	132.9	
	Sragen	n.a.	90.0	n.a.	75.0	n.a.	140.0	
	Av.	74.0	87.1	84.9	83.2	82.5	136.5	91.4
Maize	Sukoharjo	34.4	39.7	43.5	48.8	51.4	61.7	
	Sragen	34.5	33.0	46.5	51.0	54.8	69.6	
	Av.	34.5	36.4	45.0	49.9	53.1	65.7	47.4
Cassave	Sukoharjo	20.6	15.6	14.5	16.2	17.8	22.6	
	Sragen	19.2	12.8	15.0	18.1	18.1	29.6	
	Av.	19.9	14.2	14.8	17.2	18.0	26.1	18.4
Peanut	Sukoharjo	145.4	153.7	231.7	231.8	210.0	248.8	
	Sragen	131.4	158.3	208.5	245.6	256.0	266.7	
	Av.	138.4	156.0	220.1	238.7	233.0	257.8	207.3
Soybean	Sukoharjo	92.2	120.3	143.6	124.1	141.1	168.0	
	Sragen	108.2	117.9	132.2	140.7	172.4	214.4	
	Av.	100.2	119.1	137.9	132.4	156.8	191.2	139.6

Source: Dinas Pertanian, Karesidenan Surakarta

Note : All the prices are those of medium quality.

n.a. = not available.

Annex 1 Data for Estimating the Productivity of Agricultural Products on Future with Project Condition

(1) Experimental Data for Paddy Production conducted by UNDP/FAO Survey Team on "Upper Solo River Basin Fertilizer Project"

(Dry grain t/ha)

Kabupaten	Kecamatan	A	B	C	D	E	F	G	H
(75 Dry Season)									
Sukoharjo	Kartosuro	6.95	6.75	7.10	6.10	5.80	6.80	6.00	6.85
	Baki	5.63	5.87	5.52	5.44	5.45	5.89	6.31	5.68
	Gatak	3.65	3.62	3.79	4.18	4.51	4.62	3.98	4.46
	Gatak	5.22	5.25	5.64	5.04	4.45	4.97	5.46	4.90
Karanyanyar	Kebakkramat	4.76	4.72	4.63	4.46	4.68	4.93	5.10	4.63
	Jaten	3.83	3.83	3.83	3.83	4.25	4.00	4.34	3.91
	Tasikmadu	4.59	4.68	4.76	4.93	4.85	4.76	5.02	5.10
	Karanganyar	4.34	3.98	4.30	4.11	3.98	4.01	4.01	3.83
Sragen	Gondang	6.25	5.65	6.89	6.04	6.42	6.97	4.72	7.14
	Sragen	6.44	5.97	6.21	6.72	6.67	5.63	4.87	6.42
	Sambunmacan	5.27	6.55	7.91	6.03	5.78	6.29	4.85	6.12
Klaten	Prambanan	8.35	7.99	8.22	7.92	7.88	8.26	7.80	8.03
	Pedan	2.34	1.96	1.67	2.31	2.11	2.94	2.38	2.70
	Jogonalan	5.27	5.85	4.86	5.54	5.51	5.39	5.49	5.35
Average Productivity		5.21	5.19	5.38	5.19	5.17	5.39	5.02	5.37
Converted Average Productivity (Dry stalk paddy)		8.76	8.72	9.04	8.72	8.69	9.06	8.44	9.03
(73/74 Wet Season)									
Sukoharjo	Baki	5.88	6.21	6.75	6.32	6.65	6.65	6.92	6.75
	"	4.05	4.82	4.94	4.92	5.46	6.20	4.88	5.67
Average Productivity		4.97	5.52	5.85	5.62	6.06	6.43	5.90	6.21
Converted Average Productivity (Dry stalk paddy)		8.35	9.28	9.83	9.45	10.18	10.81	9.92	10.44

Source: UNDP/FAO Experimental Result in 1975

Note /1 Conversion rate from dry stalk paddy to dry grain is assumed at 59.5 %.

(2) Production Record in well irrigated five Kecamatans in Kabupaten Klaten for three years (1973-1975)

(dry stalk paddy t/ha)

Kecamatan	73	74	75	Average
Kebonarum	5.6	5.9	5.9	5.8
Delanggu	5.7	5.8	5.3	5.6
Wonosari	5.3	5.7	5.4	5.5
Juwiring	5.0	5.8	5.5	5.4
Polanharji	5.7	5.5	5.3	5.5
Average	5.5	5.7	5.5	5.6
Average of all Kabupaten Klaten	5.5	5.5	5.1 5.6	5.3

Fertilizer: Urea 250-300 kg
TSP 70 kg

Insecticide: Diazinon 2%

Source: Dinas Pertanian, Kabupaten Klaten

(3) Production Record in well irrigated four Kecamatans in Kabupaten Sragen in 1975

(dry stalk paddy t/ha)

Kecamatan	Wet season	Dry season
Sidoharjo	6.0	5.75
Sambungmacan	6.0	6.0
Gondong	6.25	6.0
Masaran	5.5	5.0

Source: Dinas Pertanian, Kabupaten Sragen

4. IRRIGATION BENEFIT AND FARM BUDGET

4.1 ESTIMATE OF IRRIGATION BENEFIT

Irrigation benefit to be excepted is the net incremental income from future without-project condition to future with-project condition. The net incremental income is estimated by using crop enterprise method.

4.1.1 Net Income Per Crop

On the basis of the estimated inputs and outputs, net income of each crop per ha is calculated both on future without-project and future with-project conditions. The results of the calculation are summarized in Table I-37, and details of the production expenses for each crop are shown in Annex 2.

Table I-37 Net Income from Crop Production

Kind of Crops	Without Project			With Project		
	Gross returns (Rp/ha)	Product expenses (Rp/ha)	Net income (Rp/ha)	Gross returns (Rp/ha)	Product expenses (Rp/ha)	Net income (Rp/ha)
Paddy						
Irrigated(wet)	236,000	96,770	139,230	324,500	114,700	209,800
Irrigated(dry)	218,300	96,770	121,530	324,500	114,700	209,800
Rainfed(wet)	165,200	73,370	91,830	-	-	-
Rainfed(dry)	129,800	67,930	61,870	-	-	-
Inundated(wet)	165,200/1	69,040	96,160	-	-	-
Sugar cane	552,000	205,200	346,800	720,000	232,270	487,730
Soybean	27,600	16,050	11,550	-	-	-
Peanut	47,500	29,480	18,020	-	-	-
Maize	14,000	11,710	2,290	-	-	-
Cassava	42,900	19,250	23,650	-	-	-

/1 In order to avoid double counting for irrigation benefit and flood control benefit, the same productivity as the rainfed paddy in wet season is applied assuming that the inundated area can produce 2.8 t/ha under the condition without flood.

4.1.2 Incremental Income from Agricultural Production

Applying the net income per crop estimated above to the crop area, total returns of agricultural production in the project area are estimated both on without-project and with-project conditions. The net incremental income is calculated at Rp. 7,673 million (US$18.49 million) as the difference as shown in Table I-38.

4.1.3 Irrigation Benefit

Since flood condition in Sragen area will remain unchanged after the construction of the Wonogiri dam and river improvement work, the expected flood damage on Sragen should be deducted from the net incremental income for estimating irrigation benefit.

Anticipated flood damage in Sragen area is calculated US$0.72 million/1. By deducting this damage on farm crops, the irrigation benefit is estimated at US$17.77 million.

Besides the benefit mentioned above, it is expected that additional benefits will accrue in the area outside the project area and also through the abolishment of the existing pumps.

Upon completion of the project, the area remaining outside of the project but covered by the existing irrigation system will benefit from the Wonogiri irrigation project since the irrigation water which has been used in the project area will come to be exclusively utilized for intensification of the land-use there from the present 40% to 65-70%.

An additional benefit will come out from the abolishment of about 60 existing irrigation pumps in the project area. Residual value of them is negligible after five to six years, since most of them are relatively old. Annual operation and maintenance costs for these pumps to be saved with the irrigation project are estimated at about US$70 thousand. Replacement cost for these pumps shall also be included in the irrigation benefit.

These ancillary benefits are considered to be relatively large, however, which is not incorporated in the calculation of the economic internal rate of return for conservativeness of the economic analysis.

4.2 FARM BUDGET ANALYSIS

From the farm survey, typical farm budget is prepared on future without-project condition and future with-project condition. Under future without-project condition, two different farm budgets are calculated which represent those of the irrigated area and rainfed area and one typical farm budget is estimated under future with-project condition which are presented in Chapter II of PROJECT ECONOMY in this Appendix III.

/1 Refer to Appendix II.

Table I-38 Net Incremental Income

Kind of Crops	Without-Project			With-Project			
	Cult.land (Ha)	Net income (Rp/Ha)	Total return (Rp)	Cult.land (Ha)	Net income (Rp/Ha)	Total return (Rp)	Difference (6) - (3) (Rp)
	1	2	3	4	5	6	7
Paddy							
Irrigated (wet)	12,720	139,230	1,771,005,600	49,600	209,800	10,406,080,000	7,963,013,500
Irrigated (dry)	5,530	121,530	672,060,900				
Rainfed (wet)	4,910	91,830	450,885,300	-	-	-	- 450,885,300
Rainfed (dry)	390	61,870	24,129,300	-	-	-	- 24,129,300
Inundated (wet)	900	96,160	86,544,000	-	-	-	- 86,544,000
Sugar Cane	1,830	346,800	634,644,000	2,100	487,730	1,024,233,000	389,589,000
Soybean	1,290	11,550	14,899,500	-	-	-	- 14,899,500
Peanut	600	18,020	10,812,000	-	-	-	- 10,812,000
Maize	3,090	2,290	7,076,100	-	-	-	- 7,076,100
Cassava	3,600	23,650	85,140,000	-	-	-	- 85,140,000
Total	34,860		3,757,196,700	51,700		11,430,313,000	7,673,116,300

(US$ 18,490,000)