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JRATUNSELUNA BASIN UPDATED DEVELOPMENT PLAN

PART

TUNTANG/JRAGUNG RIVERS BASINS
INTEGRATED DEVELOPMENT PLAN

PART II

TUNTANG AND RELATED RIVERS BASINS
DEVELOPMENT PLAN

APPENDIX B

AGRICULTURE AND IRRIGATION

MAY 1980

SUBMITTED BY

PRC ENGINEERING CONSULTANTS, INC.
ENGLEWOOD, COLORADO, U.S.A. SEMARANG, INDONESIA

DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MINISTRY OF PUBLIC WORKS
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JRATUNSELUNA BASIN
UPDATED DEVELOPMENT PLAN

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PREFACE

The Directorate General of Water Resources Development (DGWRD) of the Ministry of Public Works, Government of Indonesia (GOI) contracted PRC Engineering Consultants, Inc. (PRC/ECI) to provide consulting engineering services for preparing an integrated development plan for the Tuntang/Jragung Rivers in the Jratunseluna Basin. The study for the preparation of the plan started on May 16, 1979 and was scheduled to be completed on November 30, 1979.

An interim report on the study was submitted by PRC/ECI on August 15, 1979 which was discussed by all the concerned agencies on September 24, 1979 in a meeting held by the DGWRD at Jakarta. In that meeting and in subsequent discussions between PRC/ECI and DGWRD, it was the consensus of opinion of all the participants that the study on the Tuntang/Jragung Rivers should be modified by including the entire Jratunseluna Basin in certain aspects of the study. In that modified study the interrelationships of the existing, proposed and the potential development works of the Tuntang/Jragung Subbasins and those of the adjoining subbasins within the Jratunseluna Basin should be examined. Thus, the master plan for the development of the Jratunseluna Basin which was prepared earlier by NEDECO in the year 1973, would be reviewed and updated. The changes in criteria and constraints which have occurred and the large amount of new data which have become available since preparation of the original master plan would be incorporated in the modified study for formulating a conceptual optimized development plan. The original contract between GOI and PRC/ECI for the engineering services was, therefore, amended to include the revised scope of work for the modified study.

For the preparation of the integrated development plan for the Tuntang/Jragung Rivers, as contemplated originally, a report was prepared on Agriculture and Irrigation for supporting the proposed plan. That report is being produced as Appendix B - Part I. Agriculture and Irrigation, related to the Tuntang/Jragung Rivers Basins Integrated Development Plan.

The above mentioned modified study to update the Master Plan for the Jratunseluna Basin was started in December 1979 and completed in May 1980. The results of that study, pertinent to agriculture and irrigation, done by the consultant to support the proposed plan are reported in this document as Appendix B - Part II. Agriculture and Irrigation, related to the Tuntang and Related Rivers Basins Development Plan.

Semarang, May 1980 PRC Engineering Consultants, Inc.

PART I

TUNTANG/JRAGUNG RIVERS BASINS
INTEGRATED DEVELOPMENT PLAN

APPENDIX B

AGRICULTURE AND IRRIGATION

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APPENDIX B - PART I

AGRICULTURE AND IRRIGATION

The purpose of this part of the appendix is to present results of the study made of the existing irrigation and agricultural practices in the designated Tuntang and Jragung service areas, and to propose cropping calendars and patterns and other measures for development in this part of the Jratunseluna Basin. This study was made by PRC Engineering Consultants Inc. during the period June - November 1979 as a part of the work done on the preparation of an integrated development plan for the Tuntang/Jragung River Basins.

The location maps of the Basin and the potential irrigation service areas are shown in Figures B-1 and B-2.

B.1. AGRICULTURAL SITUATION IN THE SERVICE AREAS

B.1.1. Tuntang Service Area

B.1.1.a. Soils

The soils in the service area were classified by the Department of Soil Science Bogor Agricultural University in 1972 as alluvial soils and Grumosols [1]. The soils appear to be vertic, relatively impermeable and do not exhibit distinct alluvial and illuvial horizons. They appear to have marks of processes that have mixed the soil, over a period of time, and have prevented the development of diagnostic horizons that one might otherwise expect. Vertisols are clayey soils that have deep wide cracks at some time of the year and have a high bulk density.

Vertisols make up a relatively homogeneous order in a morphic sense. Nevertheless, variations in moisture regimes and in related soil colors are wide. There are also differences in base saturation, percentage of carbonates and depth to a lithic or paralithic contact.

There are differences in the structure of the surface horizon, and these differences are important in the use of the soils for cultivated crops. A few of the soils, in isolated instances, appear to have a surface mulch of fine and medium granules, about 5 cm thick. This mulch, if destroyed by cultivation, reforms on a single drying. At the other extreme, the surface horizon of the majority of the Vertisols is massive and very hard when dry and a seedbed for diversified crops can be extremely difficult to prepare. On partial drying, deep and wide cracks are formed. A small area was observed to have a thin crusty surface layer or horizon, generally less than 5 cm thick, that does not crack or has only very small cracks. In these soils the cracks in the deeper layers are wide.

When rains come, water commonly runs into the cracks so that the soil remoistens both from below and from above. Therefore, the defined soil moisture regimes have little meaning. Some materials from the upper layers commonly fall or are washed into the cracks. As the soil becomes moist the clay swells and the cracks close, generating pressure. Even if no soil has been added in the cracks, when the soil remoistens from below, the lower horizons swell before those above them and movement of one part of the soil against another takes place. The pressure is exerted in all directions, but the soil can move only upward and horizontally. The result is soil movement in an intermediate direction at an angle from the horizontal. This movement is the probable origin of the slickensides, the gilgai and the wedge structure that are used to define this soil order.

(i) Land Classification

The specific criteria used for classifying the soils were based predominantly upon physical and chemical factors. The land classification is not an economic classification and has limited applicability for predictive purposes. The following data and information were extracted from the 1972 soil survey report of the Glapan-Sedadi Irrigation Systems for the Tuntang service area:

Diversified Crops		Rice	
Class	Subclass	Class	Gross Area (ha)
3	3 d	2R	839
4	$4sd_2$	2R	2,425
	$4sd_3$	1R	5,337
	$4sd_2$	1R	1,975
	$4sd_3$	1R	22,025
	$4sd_4$	1R	378
	Total Gross Area		32,979

The classification for diversified crops indicates that all of the soils are in land class 3d or 4 and are unsuited for diversified crop production. Approximately 75 percent of the soils have a permeability rate of less than 0.1 m/day and deep percolation losses of 1.5 mm/day appear to be acceptable. Only 5 percent of the soils have a medium nitrogen content (the rest are low or very low). Ninety nine percent of the soils are low in phosphorus and 87 percent are high in pottasium. Sixty percent of the soils were classified as having a basic soil reaction and 40 percent were neutral.

In 1972 a total of 5,794 ha on non-productive land (villages, swamp, cemetery, etc.) was mapped, giving a gross arable area in the Tuntang service area of 27,168 ha. The net irrigable area in the Tuntang service area was estimated to be 21,857 ha, comprising the following sub-project areas:

Sub-Project	Estimated Net Irrigable Area (ha)
Glapan East	6,315
Glapan West	8,140
Grogol East	505
Karangasem	700
Bonangrejo	1,270
Grogol West	3,935
Prauwvaart East	992
Total	21,857

(ii) Salinity

The two major areas affected by salinity are Prauwvaart and Grogol. A salinity study of the Prauwvaart area was made by NEDECO in 1973 [2]. The main causes of salinization were reported to be:

1. Overtopping of bunds with salt water
2. Inflow of salty water through surface layers
3. Irrigation with salty water flow
4. Underground seepage flow from the internal drainage system.

The NEDECO report indicates for the Prauwvaart area that 78 percent of the land area is between 0.50 and 1.0 m MSL and that yield reductions of 25 and 7 percent occur for elevations 0.5 m - 0.75 m and 0.75 m - 1.0 m MSL, respectively.

In addition to the Prauwvaart and Grogol areas there are isolated areas in the Jragung service area that exhibit saline conditions. The reason for salinity, the area affected and yield reductions are not known at this time.

B.1.1.b. Crops Grown and Cropping Methods

(i) Rice

There is a mixture of rice varieties currently grown in the area, however, the area of each variety is unknown. HYV's grown consist of: IR 26, IR 28, IR 30, IR 34, IR 36, PB 8, CA-63, and Pelita. Some of the local rice varieties raised are: Dewi Shinta, Kretek, Cekri, Mantu, Markati, and Cempo Perak. Farmers have recognized the value of insect resistant HYV's, however, they have expressed concern over the availability of seed.

Rice growing techniques follow those that are commonly used in paddy rice cultivation in Java. Following saturation by rainfall or irrigation, land preparation commences. Fields are plowed once, either manually or with draught animals. The farmers usually allow two to four-week submergence of the field to partially decompose the plant residues from weeds and previous crops and to leach toxic materials out of the soil. Harrowing and land levelling usually takes two weeks or longer. Land preparation generally takes from 6 to 8 weeks, except in those areas where three crops of rice per year are grown. Where the farmer grows three crops of rice the land preparation period is about 20 days.

Rice seedlings are grown in a nursery by the wet-bed method. It is estimated that rice nurseries occupy about 5 percent of the rice growing area. Seedlings are usually transplanted after a 30-day growing period on the nursery except under intensification when a 20-day period is more common.

Local varieties (LV) are generally randomly transplanted whereas, many of the farmers use the line method for transplanting the HYV's. The recommended spacing for transplanting HYV rice is 20 x 20 cm or 25 x 25 cm, however, it has been observed that this spacing is not adhered to by many farmers.

After the seedlings have recovered from transplanting shock, the farmers try to keep 6 to 10 cm of water on the rice field during the growing period. If possible, the only time the water level is permitted to drop from this land is when fertilizer is applied. Maintaining a deep water level in the paddy for weed control is not generally practiced by the more progressive farmers as the weeds are manually removed.

The paddys are usually drained 10 to 15 days prior to maturity to hasten ripening. Harvesting is done by hand and a uniform method of harvesting is lacking. Some farmers harvest the rice by cutting the heads and others cut the rice a few centimeters from the ground.

The average length of growing season for rice from date of transplanting to maturity varies by variety and season. The average length of growing season, in days from transplanting, for the most popular varieties is as follows:

HYV Variety	Wet Season	Dry Season
IR 36	90	85
IR 34	90	85
IR 30	90	85
IR 26	105	100
C4-63	110	105

Local Varieties		
Dewi Shinta	125	115
Kretek	110	-
Cempo Perak	120	-
Other Local Varieties (LV)	130-140	-

Weeding, Insect Control and Plant Disease

Weed control is accomplished by two methods, manual pulling of weeds and a hand pushed rice weeder. Local rice varieties are manually weeded because the method of planting is such that a hand pushed weeder cannot be used. Weed control has been reported by the Department of Agricultural Extension as good.

Insect control, other then using insect resistant varieties is seldom carried out. Diazanon is the most commonly used insecticide. Spraying for insect control, if at all, is done by the more affluent farmers who have access to credit. The lack of awareness, prompt action and very poor distribution of sprayers and insecticide are contributary causes of damage by insects. In the Demak Regency in 1977/78 it was reported that yields were reduced by about 15 percent because of insect damage.

Diseases cause minor yield reductions in some years. A serious threat, because of disease, does not appear to be a problem for continuous rice production. In 1977/78 it was reported that 1,141 ha of rice was infected with mildew in the Demak Regency.

Other Damages

Rats, mice, birds, wind, flooding, drought and storms cause crop damage. Rats, mice, crabs and birds are the main pests in the area. Rat and mice damage is greater in the storage sheds than in the field. Rat and mice damages were reported on 2,177 ha in 1977/78 and the damage was estimated to be 15 percent.

For the 1977/78 period flood damage of 20 percent was reported on 12,935 ha of which 819 ha were completely destroyed; and drought damage of 20 percent on 133 ha was sufficient so that this area did not produce any grain.

Yield and Area Grown

The average rough rice yield for the period 1971 to 1978 was 2.1 t/ha. Yields reported by the Department of Agricultural Extension for Demak and Grobogan Regencies are:

Demak Regency		Grobogan Regency	
Year	Yield, t/ha	Year	Yield t/ha
1971	1.6	1971	1.8
1972	1.5	1972	2.0
1973	1.9	1973	1.8
1974	2.3	1974	2.0
1975	2.1	1975	2.4
1976	1.9	1976	3.0
1977	2.7	1977	2.9
1978	2.9	1978	3.4
Average	2.1	Average	2.4

The BIMAS and INMAS programs which are well known and have been described in many reports have reported the following yields for Demak and Grobogan Regencies:

BIMAS & INMAS Rough Rice Yields (t/ha)

Demak Regency

	BIMAS Assisted HYV		INMAS Assisted HYV		Non-Intensive LV	
Year	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season
1974	4.2	6.5	-	-	2.2	1.7
1975	2.5	4.2	-	-	1.4	1.9
1976	3.4	4.8	-	-	2.2	2.4
1977	3.8	5.3	3.6	4.7	-	1.9
1978	-	4.2	-	3.6	-	-
Average	3.5	5.0			1.9	2.0

Source: Jratunseluna Project Office, Semarang, 19 July, 1979.

Grobogan Regency

	BIMAS Assisted HYV		INMAS Assisted HYV		Non-Intensive LV	
Year	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season
1974	3.9	4.1	3.3	4.0	2.2	2.9
1975	3.8	3.7	3.5	3.2	2.4	2.4
1976	4.1	4.3	3.6	3.9	2.0	2.7
1977	4.3	4.4	3.7	4.2	2.5	2.9
1978	-	4.4	-	4.2	-	2.9
Average	4.0	4.2	3.5	3.9	2.3	2.8

Source: Department of Agricultural Extension, Semarang, 13 July, 1979

Dry season yields for the BIMAS and INMAS assisted areas are slightly greater than wet season yields. The assistance program produces yields that are slightly more than twice the average yield for the 1971 - 1978 period.

Area of rice grown in Demak and Grobogan Regencies and the area assited by BIMAS Program in 1978 are as follows:

	Total Area (ha)		BIMAS Assisted (ha)		Local Variety (ha)	
	Demak	Grobogan	Demak	Grobogan	Demak	Grobogan
Wet Season	54,446	58,607	12,567	10,271	296	822
Dry Season	20,136	9,285	664	689	-	-

Source: Department of Agricultural Extension, Semarang.

In 1978 the following areas of rice and surjan were reported for Jragung and Glapan-Setu sub-project areas:

	Area (ha)		
	Jragung	Glapan-Setu and Polder Sayung	Total
Rice	1,039	1,039	2,078
Surjan	2,650	484	3,134
Upland	423	19	442
Total	4,112	1,542	5,654

Source: Jratunseluna Project Office, Semarang, 19 July 1979.

(ii) Maize

Maize is a common dry season crop in the area. It is planted after the wet season rice crop has been harvested in those areas that do not have enough water for a dry season rice crop. In rainfed and non-irrigated areas, maize is commonly planted in October and harvested in December or January. In the areas that are irrigated and have adequate water for a second (dry season) rice crop maize is not grown.

Most of the maize varieties are of local origin, white grain, low yielding, about 0.90 t/ha (0.64 to 1.73 t/ha in 1978), and has a growing period of about 75 days. It was reported that planting is done with a planting stick and without any formal land preparation.

Maize is regarded as a supplementary food for home consumption when there are inadequate supplies of rice. It is believed by many agricultural extension people that maize will not be grown when and if there is an adequate water supply for a dry season rice crop. Farmers who may desire to grow a palawija crop after dry season rice are expected to select a crop other than maize. Maize could be interplanted with a selected palawija crop

(iii) Soybeans

Scattered small areas of soybeans can be found. In several areas it was observed that soybeans were interplanted with corn or grain sorghum. In general, the soil texture and present poor soil drainage condition are not conducive for soybean culture. Soybeans are generally grown as a quick "catch crop" which takes advantage of the rainfall occuring in the transition period between the dry and wet seasons that often occurs in September-October (Labuhan season) and are harvested prior to the onset of the rainy season.

A fine, well drained seedbed is prepared. A short season local variety that matures in about 2½ months is usually grown. Fertilizer is not used. Weed control has been described as fair to adequate and only a very few farmers use insectisides. Soybeans are not irrigated because of the lack of adequate irrigation water and are dependent upon rainfall and subsoil moisture. Yields are low and averaged about 0.71 t/ha in 1977/78.

(iv) Sorghum

Sorghum is being recommended by the agricultural extension agency and it appears to be increasing in popularity as a dry season crop where irrigation water is not available. It is more drought tolerant and has higher yields than maize. Sorghum is regarded by the farmers as a low class supplementary food. Poor taste, storage problems and low market price are the main constraints. Yields average 1.8 t/ha with a range of 1.13 to 2.34 t/ha in 1978.

Sorghum is usually planted in July and harvested in October. Varieties are variable in their growing season and new improved open pollinated varieties have increased the popularity and yield. Fertilizer, if used, is applied at the rate of 100 kg of urea per ha. Insect control is not practiced and weed control practices (manual weeding) appear to be satisfactory.

Sorghum is not expected to be grown when adequate irrigation water becomes available.

(v) Tobacco

Tobacco is a realtively new crop to the area. A considerable amount of air dried tobacco is grown in the Glapan Setu, Ketitang, Upper Tuntang and Jragung areas by the Surjan (raised bed) method. Scattered fields of tobacco have been observed which were planted in May and June on rice land after the rice crop was harvested. However, most of the tobacco is raised by the surjan method.

Land preparation for tobacco in a rice field is very thorough. It usually consists of a plowing and a considerable amount of hand hoeing to prepare the seed bed. Seedlings are transplanted with a spacing varying from 75 cm to 100 cm. Plants are manually weeded. Weed control is very good and insect control with DDT or diazanon is carried out as required. Leaves are picked over a three-month period, commencing in August.

With full irrigation it is anticipated that tobacco production in rice fields will decrease. However, tobacco production by the Surjan method (raised beds) has a yield of about 600 kg/ha and will continue and may increase because gross returns of Rp. 120,000 to 150,000 per ha can be achieved.

(vi) Cassava and Sweet Potatoes

Cassava and sweet potatoes are predominantly grown on the lighter alluvial soils and on surjan beds. However, sweet potatoes are better adapted to the heavy clay soils than cassava and other root crops. Cassava is grown where it can be easily harvested when the demand arises. These two root crops are primarily used as supplementary vegetables and only constitute a small part of the diet. Cassava yields are about 5.5 t/ha (3.47 to 7.13 t/ha in 1975) and sweet potato produces about 4.4 t/ha (3.15 to 5.14 t/ha in 1978), fresh tuber weight, respectively.

(vii) Miscellaneous Crops

Other crops such as groundnuts, mugbeans, green beans, water melon, vegetables, chili pepper, caster bean, and sesame are raised. However, the present hectarage is very small and many will become obsolete with full irrigation except as wet season crops on surjan beds

(viii) Yields of Selected Diversified (Palawija) Crops, 1977/78 Demak Regency

Crop	Yield, t/ha
Maize	0.90
Cassava	5.53
Sweet Potatoes	4.39
Peanut	0.75
Soybeans	0.71
Green Beans	0.54
Sorghum	1.78

Source: Department of Agricultural Extension, Semarang, July 13, 1979.

B.1.1.c. Present Land Use

The present land use for the estimated net irrigable area which s irrigated by diversions from the Glapan weir were determined from vailable data and visual observations. The area currently irrigated y the Glapan weir includes 3,612 ha located west of the Telong River n the Dangi subdistrict. The cropping intensity in this area eraged from 2.24 in 1976 to 2.71 in 1978. Most of the area is irrently trying to raise 3-rice crops per year but is limited by vailable water supplies. Being close to the Glapan weir is of onsiderable importance.

According to the PU Pusat Wilayah Semarang records, all wet season rice in the Tuntang/Jragung area is produced by rainfall and wet bed rice is raised only in the dry season by irrigation. The boundaries of the subdistricts of seksi Tuntang do not correspond in general to the irrigated areas. Therefore not all data could be used or evaluated. The 1974 and 1975 records are not complete. Indications are that there has been a gradual increase in dry season cropping intensity since 1972. There appear to be two reasons for this: (1) rehabilitation of the system by PROSIDA and (2) the BIMAS/INMAS programs including HYV s and fertilizer. In order to obtain a reasonable present condition level of crop intensities,the average of the 1976-78 period was used. Also, the intensities were estimated on only rice land, all surjan land with its multiple cropping system and 2 crops/ha/year was excluded.

The net irrigated area was re-estimated from a schematic drawing supplied by the Jratunseluna Project Office dated 2 October 1978 and making corrections for arithmetical errors based on the assumption that the hectarages given were correct. The net cultivated area for the Tuntang Project including the Glapan Setu, Ketitang, Grogol West areas less the Dangi area was 25,088 ha. This differs from earlier estimates of 24,248 ha etc

In order to properly utilize the Tuntang water, the dry season irrigated crop hectarage of the Dangi was transferred to the Tuntang area since under the revisions made by the Jratunseluna Project this area would be irrigated from the Serang River. The surjan area was estimated to be 2,054 ha. The entire area (23,034 ha) was considered to produce a wet season crop of rice. The dry season rice production was determined from the harvested irrigated rice areas indicated in the Gubug, Demak, Singen kidul and Dangi areas. The crop intensities for 1976-1978 were 1.46, 1.67 and 2.11, respectively. The average was 1.75. A cropping pattern that would provide this annual intensity was estimated as follows:

	Area	Crop-ha
Surjan	2,054	2,054
1-rice crop	10,966	10,966
2-rice crops	5,859	11,718
3-rice crops	4,739	14,217
1-rice crop + 1 upland	1,000	2,000
2-rice crops + 1 upland	470	1,410
	25,088	42,365

$$\text{Intensity} = \frac{42{,}365 - 2{,}054}{25{,}088 - 2{,}054} = 1.75 \text{ w/o. surjan}$$

$$\text{Intensity} = \frac{42{,}365}{25{,}088} = 1.69 \text{ w/surjan.}$$

B.1.1.d. Present Cropping Pattern/Calendar

The present cropping pattern and calendar is quite diverse. In the Demak Regency it has been reported that during most years there is sufficient water, either by rainfall or irrigation, to commence land soaking and land preparation in October. Transplanting of rice usually commences in November and continues into March. In 1978/79 three crops of rice are grown on about 19 percent of the area; about 25 percent of the area produces two crops of rice with some palawija; about 4 percent of the area has enough water to raise one crop of rice and a palawija crop; and about 44 percent of the area raises only one rice crop a year

There is an unknown area in surjan producing a multitude of different crops. In 1972 about 4 percent of the area was in surjan and this method of cultivation is expanding, especially in those areas where water deliveries are uncertain. It was estimated at about 8 percent for the present condition (1979).

The scheduling of crops grown by the surjan method is quite erratic. However, tobacco appears to have replaced soybeans and peanuts in the dry season. During the wet season maize and other crops are raised on the beds and are followed by tobacco in April or May.

It is emphasized that the farmers in those areas in and near the Tuntang River that can obtain water during the dry season are raising three crops of rice a year

B.1.2. Jragung Service Area

The Jragung service area has been described in the Upgraded Feasibility Report and the Final Design Report for the Jragung Multipurpose Project [3, 4]. The service area consists of the following subproject areas:

Sub-Project Area	Estimated Net Irrigable Area (ha)
Jragung Right	1,101
Jragung Left	3,011
Pamongan	1,502
Guntur Left	1,554
Guntur Right	383
Total	7,551

There are two sub-project areas that are physically located in the Jragung service area but are irrigated with water from the Tuntang River via the Glapan-West Canal. They are:

Sub-Project Area	Estimated Net Irrigable Area (ha)
Ketitang	626
Glapan Setu	1,545
Total	2,171

The only noticeable major change taking place during the last three years is a large increase in the hectarage of tobacco. Tobacco is grown by the surjan (raised bed) method of cultivation and is usually followed by maize in the wet season. The area producing crops by the surjan method is rapidly increasing and it is doubtful if there will be any sizeable decrease in surjan with the advent of delivery of water by irrigation. Interviews with farmers indicate that they are unwilling to go back to rice cultivation as they have a much higher income from their present practices.

Surjan is the practice of preparing the ground into raised plots 2 to 5 m wide with ditches 0.75 m to 4 m between the beds so that the ground surface is about 0.50 m to 1.0 m above the bottom of the ditch. Diversified or upland type crops are grown on the raised beds and rice in the ditch or low area between the beds. Except for tobacco the cropping pattern for surjan is quite complex. A system of interplanting is usually employed where diversified crops are grown. The major diversified crops grown are maize, soybeans, peanuts, chilli, cassava and sweet potatoes with soybeans and peanuts giving way to tobacco in the dry season.

The present land use pattern for the estimated net irrigable area was determined from available data and visual observations and is tabulated below.

Sub-Project	Surjan	2 Rice Crops	1 Rice + Palawija	1 Rice Crop	Total
East + West Jragung	3,073		311	728	4,112
Pamongan	325		353	824	1,502
Guntur Left		1,165		389	1,554
Guntur Right		383			383
Prauwvaart West				3,150	3,150
Prauwvaart East				992	992
Total	3,398	1,548	664	6,083	11,693

The soils in the Jragung service area have a low soil fertility level; all of the soils are low in nitrogen; 77 percent are low in phosphorus, 8 percent are medium, and 15 percent have a high phosphorus level; and 75 percent of the soils are high in pottasium and the rest of the soils have a medium pottasium level. In 1972, eighty four percent of the soils in the service area were classified as IR and 16 percent were classified as 2R.

As previously mentioned the cropping pattern is very complex. It is very difficult to estimate the cropping intensity, especially with the surjan method of cultivation. However, if surjan is considered as two crops (wet and dry season) then the estimated cropping intensity is 1.48 and 1.27 if the surjan is not included.

The present situation for the Tuntang - Jragung Project is as follows:

	Crop Area - ha			
Cropping Pattern	Tuntang	Jragung	Total	Percent
Surjan	2,054	3,398	5,452	14.82
1-rice crop	10,966	6,083	17,049	46.36
2-rice crop	5,859	1,548	7,407	20.14
3-rice crop	4,739	-	4,739	12.88
1-rice + 1 upland	1,000	664	1,664	4.52
2-rice + 1 upland	470	-	470	1.28
	25,088	11,693	36,781	100

$$\text{Intensity} = \frac{50,818}{31,329} = 1.62 \text{ or } \frac{61,722}{36,781} = 1.68 \text{ (w/surjan)}$$

B.2. PRESENT STATUS OF THE IRRIGATION-DRAINAGE SYSTEMS

B.2.1. Existing Irrigation Systems

The Tuntang - Jragung Project area lies in the western portion of the Jratunseluna Basin to the east of Semarang. Two, run-of-river irrigation systems lie between Semarang and the project area. These are the Dolok and Pucanggading Systems. The Jragung System is made up of five subproject areas: Jragung East, Jragung West, Pamongan, Guntur Left, Guntur Right. There are two subproject areas physically located in the Jragung area which are served from the Tuntang River via the Glapan West Canal: Ketitang and Glapan-Setu. The Prauwvaart area west of the Semarang - Demak Highway is an area irrigated by return flow from the Jragung Area. The Tuntang River Project is divided into an east and west subproject area. The Grogol West area connects to the Tuntang East Subproject area and is located west of the Demak highway between the Tuntang River and Djadjar Drain. The project and subproject area locations are shown on Figure B-1.

The projects are under the control of the Department of Public Works (DPU). The chain of command goes from the Provincial office, located in Semarang to the Semarang District (Wilayah) to the Tuntang Sub-District (Seksi) to the operation Sections. The DPU exercises control of both operations and maintenance. Neither of these functions are effectively carried out due primarily to policy constraints imposed by the National Government and DPU Jakarta. At the present time, the Jragung Project is under rehabilitation and is non operational. The Tuntang Project is operational and serves a larger wet season area than dry. The available dry season flows are fully exploited by the local farmers.

Rehabilitation and new construction are all under the control of the Jratunseluna Project office. This not only includes the regular requirement of Public Works to design and construct the conveyance system down to the Tertiary turnout plus 50 meters but now includes the implementation of the new Tertiary Program that conveys water to the quarternary units.

The following sections cover in greater detail the features of the Tuntang-Jragung project including the physical features, rehabilitation and tertiary development programs and possible constraints to optimum rice production.

B.2.1.a. Pucanggading Weir

The Pucanggading Weir located some 3 km south of the Solo-Surabaya highway on the Penggaron River serves an area of some 4,590 ha. Both a left and a right bank canal head on the weir. On the right bank, a feeder canal traverses a distance of about 1 kilometer to division structure BPKa where a right main canal (BM) crosses to the east and hence along the Oosterleiding Drain. The Sayung Drain serves as the projects northern boundary. The left main canal (BL) extends north from BPKa along the right bank of the Penggaron River to the Babon drain then west across the Semarang-Demak highway.

A left main feeder canal extends from the weir to division structure BPKi where a secondary canal takes off and parallels the Eastern Banjir Canal toward Semarang while the main canal follows along the left bank of the Penggaron River. Two major secondary canals head on the main canal at BT1 and BT2, respectively and serve a major portion of the west bank area.

The Pucanggading system is in a poor state of repair. The supply appear to be inadequate to irrigate the proposed area and the canals and laterals cannot, in general, carry water to the tail structures. As a result it is estimated that only 2,000 ha receive some form of irrigation water. In addition to the inability of the conveyance system to adequately supply water to the paddies, the city of Semarang, or the non-farm population associated with the city are locating in the area and converting both potential and actual farm land into urban land. With an apparent lack of zoning to prevent the settlement of the agricultural land, the Pucanggading area will cease to be a major agricultural area in the future, first on the left bank and later on the right. The drainage area above the weir could supply municipal and domestic water to the region if the service area is converted by urban sprawl but unless quick action is taken now to zone it and keep out development, this source of water will not be available.

The Pucanggading area is located at too high an elevation to be served from the Glapan Weir on the Tuntang River without a pump relift. The Jragung River does not have an adequate water supply and it also appears that a pump relift would be required although, the head would be considerably less than that for water coming from the Glapan-Setu Canal. The combination of urbanization and pumping does not make the supplying of Pucanggading area from the Tuntang attractive at this time.

B.2.1.b. <u>Dolok Weir</u>

The Barang Weir on the Dolok River is located about 8 km south of the Semarang-Solo Highway and serves a potential area of 1,956 ha. Both left and right bank main canals head on the weir. The right bank canal splits at BBka with the right branch going due east to the high ground located between the Ngrendeng and the Sumber Rivers. The left branch parallels the Dolok River. The left bank canal also parallels the river. The project extends down to the Semarang-Solo Highway and the Jragung Project area.

The project facilities are, in general, in a poor state of operation and repair. Recently the lateral Sambak has been repaired, illegal off-takes closed and water has flowed to the tail structure so that the farmers may now receive a prorated share of the available supply. NEDECO and DPU personnel established the lateral as a pilot project to improve operation, maintenance and water distribution on a small scale at the users level, i.e., the local farmers. The program should be operational in the 1979/80 wet season as water was delivered this past year. NEDECO [6] indicated a slight shift away from Surjan to flooded paddy (sawah) due to a dependable supply of water. The **farmers'** previous history was not provided nor were his 1979 dry season (palawija) cropping intensions indicated. The soils in the area affected were not defined either. This reduction in surjan indicates the potential to reconvert surjan to paddy when water is available. The amount of pressure brought by the local officials on the farmers to convert is also unknown. There are conflicting policies between the agricultural extension service people to increase upland crop production on one hand and DPU to increase rice production in their projects on the other. It is difficult to see a major conversion from surjan producing tobacco at Rp. 150,000 + per hectare per crop plus the value of the other upland crops grown during the wet season to that of irrigated rice (1 crop per year) and a dry season upland crop when rice is worth only Rp. 37,000 per crop. The economics are not there. Very little tobacco appears to be grown as a second crop on paddy land. Soil tilth and drainage appear to be a constraint. A more precise baseline study should be conducted to provide the base for determining changes brought on by improved water management and dependable supplies. Observations without facts are difficult to support economically.

The northern half of the right bank service area could be served from a lateral that would head at BTL2 on the Jragung left main canal. To serve any area not already served from Jragung would require a canal crossing at the Tjloempy River prior to its joining the Dolok right bank canal. This would be a major structure. The dependable water supply in the Jragung River is not adequate to supply the area even in the wet season. The involved land has a gross area of roughly 1,000 ha with an irrigable area of 600 -700 ha. The rehabilitated Jragung conveyance system would not have adequate capacity to supply the Dolok area in the event a dam is constructed on the Jragung and/or transbasin diversion is made available from the Tuntang.

B.2.1.c. Jragung Weir

The Jragung Weir on the Jragung River is located about 5 km upstream of the Semarang-Solo Highway. The Jragung Weir can serve an area of 6,904 ha, including about 2,391 ha that presently is served by the Glapan-Barat Canal offtaking from the Tuntang River. An area of 4,513 ha can receive water solely from the Jragung River, 1,937 ha from Jragung or the B1 River via the Guntur Weir and 4,142 ha are referred to as return flow areas. The low areas east of Demak Highway and the Guntur area are subject to annual flooding.

The Jragung Weir built in 1923, serves as the only source of water to some 4,513 ha of land; the Jragung left with 3,011 ha and the Pamongan with 1,502 ha. Construction of the Jragung Right irrigation system has been stopped until storage is built in the basin to make irrigation supplies available. The Pamongan area was rehabilitated by PROSIDA in 1975 but the tertiary system does not exist. A larger part of the Jragung area is in surjan today than it was three years ago. The lower areas where drainage water is available (return flow) are in paddy. The Jragung West is currently being rehabilitated. A large portion of the area is presently in surjan with tobacco being the main crop. The paddy area between the surjan fields are small and act as a series of drains for the area. A relatively large part of the area appears to lie at elevations above the command level of the irrigation system. Conversion of the area to paddy will depend on the economics of rice production versus upland crops (mainly tobacco), dependability of supply, availability of supply, and ability of the system to deliver water to an area.

The hourly flow records at the Jragung weir from May 1978 through March 1979 were studied in detail. The peak flows occurred during the night. Only one instance was recorded where the flow was above 12 m^3/s at 0800 hours. The records indicated that in the above 11-month period a discharge exceeded 12 m^3/s only 27 times. A linear relationship between total inflow to the weir and the calculated flow available for diversion (all flow less than 12.0 m^3/s) on a monthly basis was derived for usage in the computer simulation model for the condition without a storage dam on Jragung. The equation is;

$$Qd = 0.68\ Qi + 0.83$$

Where

Qd = flow available for diversion in $10^6\ m^3$/month
Qi = inflow to Jragung Weir in $10^6\ m^3$/month.

The correlation coefficient (r^2) was found to be 0.97. A correlation for daily flows was not derived although the data is available.

In addition to the Jragung West and Pamongan areas the Jragung Canal delivers water to the Glapan-West Canal and hence to the Ketitang and Glapan-Setu areas which cover some 2,171 ha. Under normal run-of-river conditions it does not appear that significant water would be available for these two subproject areas but will depend on future diversions into the Jragung West and Pamongan areas. If the percentage of surjan area remains near the present levels only minor irrigation releases should be required to irrigate the rice grown between the raised beds and the paddy located in the low, poorer drained areas near the natural drains. This could leave some water available for the Ketitang Glapan-Setu areas. All flows passing the Jragung Weir are available for rediversion at the Guntur Weir.

Implementation of the East Jragung area is being held in abeyance until a final decision is made on providing a storage on the system. Without storage, there is not sufficient water in the river to irrigate this area. The area is presently in surjan and rainfed paddy.

The return flow areas east of the Demak Highway are only partially served by any kind of technical or semi-technical facilities. Much of the area has been subject to annual flooding in the past. The Jratunseluna Project is currently, with the assistance of NEDECO, implementing a drain improvement scheme. This project has had its problems but work is continuing. The Gemboyo River is under rehabilitation. The current problems observed in the field such as poor adherence to excavation pay lines and embankment compaction will be solved and it is assumed that the improved drainage system will be operational prior to 1987. The Prauwvaart area on the west side takes water from the Prauwvaart Canal which parallels the Demak Highway and has the water level controlled by a series of gates located on sea drains. In addition to controlling the upstream water surface elevation the gates prevent salt water intrusion from crossing the road.

Irrigation releases are not made for the return flow areas. Only water that is in the drains from the upstream areas is available for rediversion. The return flow consists of excess rainfall occurring on both the cultivated and noncultivated lands, ground water seepage into the drains and waste water from the conveyance system and irrigated areas. Thus, the return flows will be high in the wet season and low in the dry season. Dry season return flows will require either a gated diversion structure to raise the water surface above ground surface or pumping. Although pumps are not now used extensively in the area, their use has been observed in the project area. Three years ago, no pumps were observed in operation in the irrigating paddies and surjan areas, where as this year several pumps were observed. In the next few years a proliferation of pumps will probably occur.

The production of tobacco in the area would benefit considerably from supplemental irrigation, and rice production can be maintained in areas where structures are not available in the drains or canals to raise the water up into the paddies. Pumps will replace, to some extent, illegal turnouts and provide irrigation to areas where the land surface is higher than the water surface in the canal.

B.2.1.d. Glapan Weir

The Glapan Weir is located on the Tuntang River some 9 km upstream of Gubug. The weir was constructed in 1859 with only a right bank head works. The left bank head works was constructed in 1970. The service area has an irrigated area of 24,760 ha. The Glapan East Canal heads at the right bank head works. It has a capacity of 16.0 m^3/s and serves an area of 12,789 ha. The canal has a 9-m bottom width and a slope of 0.000164. At km 2.06 the T-1 secondary canal head regulation is located with discharge capacity of 7.4 m^3/s and a service area of 6,940 ha. The east main canal crosses the Banyuasin River, which has an estimated peak design flow of 461 m^3/s before reaching the head regulator for the T-21 secondary canal which has a design discharge of 6.6 m^3/s and a service area of 1,783 ha. This canal has an extra 5,016 m^3/s capacity available for the future Grogol West area. In the future the Teleng River will be the boundary of the Tuntang Project if a storage dam is constructed on the Serang River. At the present time the Dangi area contains 3,612 ha which is served from the Glapan East Canal with a discharge capacity of 6.9 m^3/s when it crosses the Teleng River. Some 575 ha are served directly from the Glapan East Canal before it crosses the Teleng River.

The T-1 and T-21 canals rejoin at structure KW 33 on the T-2 canal. The service area below the junction is 4,685 ha and the design discharge is 5.1 m^3/s. The flow from T-21 canal is minimal. A major drain crosses under the T-21 canal at the BML 8 complex. The Teleng River flows into the Djadjar Drain which makes the Tuntang Project boundary all the way to the coast. The Djadjar Drain by-passes an old Tuntang River bed that once flowed through Demak. The old channel is still used for local drainage. The Djadjar Drain has a low weir constructed across the channel just north of the highway bridge which ponds water some 50-75 cm above the sea side to prevent salt water intrusion. The local population also constructs, annually, a temporary earth dam across the mouth of drain to prevent seas water intrusion and allow the people to use the fresh back water. Most of the area east of the Demak highway between the old river channel in Demak to the new Tuntang River channel in Karangtengah is rainfed and referred to as the Grogol area. Conditions in the area are similar to those in the Prauwvaart area with saline soils that lie from 50 to 75 cm above mean sea level. Proposals have been advanced to irrigate the area.

Much of the Glapan East area including the Dangi area was being planted to a third rice crop in July 1979. The flows were still high in the Tuntang River. The Semarang District office indicated that nearly 14,400 ha were still in rice at that time. Rotational irrigation was taking place between reaches of the secondary canals and the laterals leading from them. Water use efficiency was at its peak as little water was being wasted. Cooperation and sharing of water appeared to be the general rules. Very little flow, probably on the order of 10 percent of the diversions, was observed in the drain. The historic record of irrigated areas in the Tuntang Project area is available in the district office. These areas change according to the available supply. Since parts of the Tuntang area have adopted multiple cropping of rice, the land preparation period and work load has been spread out more uniformly over the year so that areas are in all stages of production in adjacent fields, i.e., land preparation and nursery, transplanting, vegetative growth, reproduction, ripening and harvest. Since the farmers know what the status of flow in the canals is they will continue to cycle the next rice crop as long as the flows are high. As the flows in the river decrease rotation irrigation starts, the farmers cut back on planted areas knowing that the flows in the canals will continue to decrease and water may not be available for the crop. Therefore, the farmer may gamble planting part of his land to a new crop in the hope that rainfall and river flows will be adequate to give him a harvest but with lower than normal yields. This means that in years when the river dries up in May there will be only small areas growing rice instead of the large areas as observed in 1979 and recorded in 1978. It also means the farmer's losses are minimal or in the range he feels he can afford.

The Glapan West Canal heads upstream of the weir. It serves an area of some 11,971 ha and has a design discharge of 9.7 m^3/s. The headworks for the Gubug secondary canal is located 975 m downstream on the Glapan West Canal from the Tuntang head works. It serves an area of 4,980 ha and has a design capacity of 4.5 m^3/s. In the next about 10 km length of the canal, an area of 1,367 ha is irrigated directly from the main canal. An area of 2,753 ha is irrigated via secondary canals prior to the Glapan West Canal reaching the Pamongan Area. The Ketitang area receives a flow of 0.5 m^3/s leaving a flow of 1.7 m^3/s still in the canal just before it crosses the Setu River into the Glapan Setu area.

B.2.1.e. Reregulation Weirs

There are three permanent reregulation weirs in the project area; Karangroto, Guntur and Gaji. The Guntur Weir is located on the B1 river and serves an area of 1,554 ha on the left bank and 383 ha on the right bank. The source of water is return flows and excess rainfall coming from the West Glapan area. This structure is currently programmed to be rehabilitated by raising the weir crest, adding new gates and a stilling basin.

The Gaji Weir is an old weir located across the Setu River in Gaji. It is an ungated structure which uses flash boards to raise the water surface sufficiently high to irrigate an area of 297 ha. The flash boards have caused upstream flooding during periods of sudden high runoff. Public Works Department (DPU) are presently planning to demolish the structure as soon as they can provide an adequate water supply to replace the present diversions. An alternative solution would be to rebuild the structure and install constant upstream head gates that could handle flood flows.

The Karangroto Weir is located downstream on the Penggaron River near the Demak Highway and serves the Legok area north of the Demak Highway.

The people near Golang living along secondary canal T-21 of the Glapan East system have applied for permission to build a permanent diversion dam on the drain that parallels the T-21 canal to replace a temporary dam that the local people construct every year and then remove during the wet season. The status of the application and the decision of the competent authority are not known.

B.2.1.f. Tertiary Project

The Central Government has initiated a tertiary construction program for the Jratunseluna Basin for an area that covers some 73,000 ha. The program under which DPU is now implementing some 14,000 to 15,000 ha is designed by the Jratunseluna Project's design office and is built by the local contractors. The program has been plagued by many problems, the most critical being the complete lack of any horizontal and vertical control, poor surveying techniques and too much office design without field verification.

The design capacities of the tertiary ditches are based on a criteria of 1.4 l/s/ha which was adopted with NEDECO's urging. This capacity does not prevent irrigation but limits the potential of the area to adopt an intensified multiple crop system. The limited ditch capacity and the recommendation for a two-month period without any crop automatically limits rice production to two crops per year. The limited channel capacity will cause land saturation to take up to 45 days depending on the rainfall and efficiencies assumed. By allowing a period of 20 to 30 days for the actual land preparation, a total period of 75 days will be needed between the time the first farmer starts land preparation and when the last one transplants his crop. This is the same as the length of the irrigation period for a growing crop. The extreme case is when no rainfall has occurred to reduce the saturation requirement below 200 mm. Average November rainfall is 217 mm and the 80 percent design rainfall [7] is 136 mm with 73 mm in the first 15 days. Effective rainfall is calculated as 58 mm using a 0.8 factor. Therefore, assuming PET = 5.10 mm/day for November, Kc = 1.0, the percolation loss is 1.0 mm/day, and the total water loss from the paddies and tertiary distribution system is 20 percent of the water delivered to the tertiary head gate; then the water requirement is 1.86 l/s/ha if delivered over a 15-day period. The G.Z.W. equation (referred to as the Goor-Zijlstra equation in the NEDECO

$$Q = \frac{ADt}{[1-e^{(-\frac{NDT}{Ds})}]\,(A-L)\,8.64} = \frac{1(6.1)}{[1-e^{(\frac{-15 \times 6.1}{142})}]\,(0.8)(8.64)}$$

$$= 1.86 \text{ l/s/ha}$$

where

$Dt = Kc \times (PET) + P = 1.0\ (5.1) + 1.0 = 6.1$ mm/d

$Ds = 200 - RE = 200 - 58 = 142$

L = system loss factor = 0.20

N = irrigation time in days = 15

A = area in ha (assume 1 ha)

The equation is sensitive to values of L, Ds and N; changes in Dt have less affect. The intense use of land will require the rapid turn around between crops. Land saturation will have to be done in hours and the land preparation in days instead of weeks. The above calculations do not include the 60 mm of water required for transplanting rice. This water also has to be applied quickly but is not required until the land preparation period is completed (4 to 6 weeks in the present system). This means that when transplanting starts the 1.4 l/s/ha discharge capacity would also have to start supplying 60 mm which would further decrease the area that could be saturated each day. Furthermore, the evaporation requirements must be replaced daily with continuous irrigation system.

B.2.1.g. Water Management

Water management is non existant in the wet season. Water is allowed to flow through the paddies and all canals are required to flow with a minimum of 70 percent of capacity if the water is available whether the crops require it or not. This means that any rainfall occuring on a paddy with flowing water contributes nothing to the crop water requirements, i.e. effective rainfall is zero. Overall project efficiency is estimated to be no higher than 30 to 35 percent in the Tuntang area but higher in the Jragung area because of shortage in supply. Dry season irrigation efficiencies will reach 80 percent or so during periods of insufficient water supplies.. Very little water makes it to the drains and some of that is rediverted back onto the land. Seepage losses in the dry season from both the canals and paddies are low due to low paddy water depth and low canal flows. If additional water supplies were available, project irrigation efficiencies would drop because of the availability and because of greater depths of standing water in the paddies. NEDECO's pilot areas should provide information on water management and system losses when the proposed areas are operational.

B.2.2. Existing Drainage Systems

There are two major drainage problem in the project area: 1) the lack of sufficient drainage capacity for the low areas east of the Semarang-Demak Highway and 2) the lack of adequate surface drainage in the tertiary units. Flooding may or may not contribute to the drainage problem. Flooding on the Tuntang and Jragung Rivers is discussed in a separate section.

Rehabilitation of the major drains and implementation of an adequate drainage system is presently being worked on by the project and the consultant, NEDECO. It is assumed that their work on the B1, B15, Cabean, Gemboyo Rivers and Wonokerto Drain will solve the major drainage problem in the Glapan West area except for local surface drainage problems. Glapan East area still has local surface drainage problems but does not appear to have major problems. Construction of storage dam on the Tuntang River will not increase local drainage problems. If properly executed, the tertiary program will solve most of the local drainage problems.

The Dolok River has almost no capacity downstream of the Glapan-Sotu Canal crossing. If the Kebonbatur Canal does not carry the excess flow into the Eastern Banjir Canal, flooding will occur downstream and will increase the drainage problem. The Gaji Weir is scheduled for removal from the Setu River which will reduce local flooding but would not affect the drainage problem in the low areas east of the Demak Highway. It is assumed that the Setu-Pulo Tulung system, Dolok River, Sayung Drain and Babon Drainage system will be adequately rehabilitated to reduce the incidence of inundation east of the Demak Highway to occurrences only due to rare meteorological events.

Maintenance of the existing drainage system within the irrigated areas is essentially non-existant. In many areas the need for outfall structures is very evident as erosion is becoming severe. The digging of borrow areas next to the irrigation canals during construction often creates two parallel drains one on each side of the canal. Such occurrences are quite common. In many cases cross drainage structure have been ignored or grossly under estimate. The new 1978 design criteria, should help where the drainage requirements have been underestimated in the past.

B.2.3. Operations and Maintenance

B.2.3.a. Organization

Operation and Maintenance of the Tuntang-Jragung Project is the responsibility of the DPU. The Department of Water Resources of the Central Java of the Ministry of Public Works has overall control and authority for operation and maintenance of all public irrigation systems. Some of this authority is delegated to the six districts that the province is divided into. The Tuntang-Jragung Project lies in the Semarang District and Tuntang Subdistrict. The subdistrict is further divided into sections each of which has responsibility for certain portions of the conveyance systems.

Information on the operations of DPU throughout the province are not well documented and information is sketchy. Budget information is even more difficult to obtain. One reason for this is that studies are constantly being made for another reorganization. The last reorganization took place in 1978.

(i) Central Java Provincial DPU

The Department of Public Works has its provincial office in Semarang, the capital of the province of Central Java. This office is responsible to DPU Jakarta and the Governor of the Province. Irrigation in the province covers approximately 570,000 ha of which 460,000 ha are technical and 110,000 ha are semi-technical. The management of this area has been divided in to six irrigation districts (Wilayah); Semarang, Pekalongan, Surakarta, Banyumas, Kedu and Pati. In the past, control over the operation of the irrigation districts has not been exercised as much as it should. In addition to the six irrigation districts, the provincial office has a water resources department, bridges and highways department, administration and technical, buildings, etc. The water resources department provides assistance to the irrigation districts and is responsible for annual budgeting for operation and maintenance. The budgets of each irrigation district are received and considered. Requests for special projects are also received and consolidated. Funds are provided by the provincial government for O & M and special small scale projects. The Central Government provides funds for major projects through the Directorate General of Water Resources Development of the DPU.

The present policy of the Government to place the major share of the annual budget into capital improvements has had a rather disastrous effect on the physical shape of the constructed facilities in the irrigation projects and operation of the systems is adversely affected. In many cases it has been observed that the system became inoperative within a few years after construction and consequently an expensive rehabilitation program was required. It is recommended that the funds should be made available at the end of a project to assure that the system is functioning as designed before it is turned over to the local DPU organization for operation and maintenance.

(ii) Semarang District

The Semarang District (Kepala Wilayah Semarang) office of Public Works has responsibility for the Tuntang - Jragung Project area along with other areas. The total irrigated area served in the district is 113,667 ha. The district has the following departments: Water Resources, Roads and Bridges, Administration, Buildings and the subdistricts of Tuntang, Serang Atas, Serang Bawah, Bodri and Rawa Pening. The Water Resources Department has the following sections: design, exploitation, maintenance, technical administration and operations. Water distribution and management come under the exploitation section while construction supervision is under operations. The number of technical staff for O & M in the district was listed as 1,167 but contained only one engineer and 13 bachelors. The breakdown or location of irrigated areas, personnel, etc. is available in the district office.

(iii) Tuntang Subdistrict

The Tuntang Subdistrict (seksi Tuntang), or section as it is sometimes referred to, is responsible for the operation and maintenance of the Tuntang-Jragung Project area as well as the Dolok and Pucanggading areas. The subdistrict is organized into a technical department, an administration department and seven operational sections (Ranting Pengamat). The operational sections (Pengamat Pengairan) are Demak, Ungaran, Plamongan (Simongan was combined in January 1979), Buyaran, Guntur, Singon Kidul, Gubug, and Dangi. The boundaries of each section as they pertain to the Tuntang-Jragung area are shown on Figure B-2. There are 61,141 ha of technical irrigation and 1,869 ha of irrigation requiring rehabilitation. The Ungaran area does not cover any of the project area at all.

The present staff of the Tuntang subdistrict numbers 348 people. The chief officer of the subdistrict is a bachelor of engineering as is his chief technical officer. There are 13 members in the technical section and 21 in administration section. The seven sections have from 27 to 79 people with a total of 313 of which 53 are day hire so that the permanent operational staff is only 260 people.

Each section has a similar organization with technical assistant, one to three administrative assistants, a number of supervisors (Mantri Pengairan) who in turn have a number of gate keepers (Juru Pintu) or common laborers working under them. The supervisors are responsible for a fixed service area which could include one or more lateral canals and a series of tertiary units. An example is the Dangi Supervisor (M.P. Dangi) who has a staff of six people. There are five major structures located along the Glapan East canal as follows: BGt8, BRW4, BGt10, BGt13, and BGt15. Each of these major structures probably has a gate keeper (juru Pintu). There are also five tertiary turnouts located along the main canal between the major structures. There are four secondary canals heading from the main structures at each of the BGt locations. There is also a structure where the Rawuh Canal which carries water from the Serang River, joins the Glapan East Canal. The secondary canals Kepoh (331 ha), Truko (185 ha), Gompeng (710 ha) and Nanjungan (1,144 ha) serve a total area of 2,370 ha. A total of 37 tertiary units measuring 3,612 ha are served in the Dangi area. The Dangi staff consists of six people.

Under the direction of the subdistrict the available water supply is allocated to the area controlled by a supervisor who in turn allocates it to the tertiary units. During periods of low flow, a rotation system of delivery is set up by the district which is in turn passed down to the subdistricts and sections to administer. In the Tuntang project water is delivered to each tertiary unit according to a schedule. The schedule by which a tertiary gets water may be rotated around in different years.

In some areas of the Tuntang Project the tertiary units have been implemented and structures and subtertiary ditches have been constructed to convey water to quarternary units. No distribution system is provided in the quarternary units which serve a total area of 10 to 15 ha. Most of the tertiary systems observed on a series of inspection trips through the Tuntang Project, where subtertiary systems have been constructed,were not in use and in many cases the farmers had by-passed the new system.

B.2.3.b. Budget

No information on budgets was made available. A total of Rp. 1.519 x 10^9 was approved for Central Java O & M from the Central Government for the fiscal year 1978/79 from which the Semarang District was to receive Rp. 291.881 x 10^6 according to NEDECO [5]. Irrigation, roads, bridges and buildings are all included in the DPU budget and, an itemized breakdown was not available. The subdistrict Tuntang received Rp. 275 x 10^6 from DPU and Rp. 205 x 10^6 from the Province.

A land tax called IPEDA (Iuran Pembangungan Daerah) is collected at the Desa level and forwarded to the Bupati. The rates levied against the land range from Rp. 12,000/ha down to Rp. 150/ha from the best land with a good water supply to inundated land with poor cropping history. This is 3-times the rate quoted by farmers in the field who indicated that Class I rice land was taxed at a rate of Rp. 3,000/bau/year or Rp. 4,200/ha. The taxes collected are to be used for local development. It is not clear whether part of these funds reach the provincial level and are used for small project development for irrigation as well as all other services.

B.2.3.c. Equipment

Little or no equipment and tools exist at the section and sub-district levels other than rudimentary office equipment and hand tools etc. The district office has some equipment and vehicles that can be used to support the sections. The extent or list of available equipment was not obtained.

B.2.3.d. Operations

These are no water operation centers or similar types of organization in the Semarang District. There have been several proposals and recommendations to establish such a center but to no avail. A general set of rules for operation of the weir are established each year in an effort to equalize distribution of low flows to the sections scheduled to receive water as well as rotation in subsequent years to sections not receiving water during the preceding year. Low flows are prorated as best the section supervisors can manage.

A problem that the section supervisors complained about was the lack of support given by the superiors in dealing with farmers caught making illegal diversions during periods of low flows. Violators would be caught and then the authorities would not fine nor punish the violations which means it becomes impossible to control illegal diversions.

B.2.3.e. Maintenance

Maintenance consists of painting and greasing the gates and moving parts and clipping grass along the canal banks. Animals are allowed to graze the banks which keeps the grass cutting by laborers down. Sediment is seldom removed from the canals. Canal banks are repaired only on a crash basis as no program of annual preventive maintenance exists. On most secondary canals, water even during the wet season seldom flows past the control or third tertiary turnout. In general, the standard of maintenance of the existing works and systems is quite poor.

Unfortunately, no action appears to have been taken so far on the recommendations made by the engineers for organizing maintenance of works and providing the necessary equipment. Until adequate funds are provided by the Government to meet all such costs, efficient maintenance will not

B.2.3.f. Construction

At the present time, all construction in the Tuntang-Jragung area is handled by the Jratunseluna Project through separate budgeting. This includes the tertiary development program as well as all drainage and irrigation improvemer

In the future, new construction would be handled by the Irrigation Division. Proposals for small projects would be submitted through the sections and subdivisions to the division. If the division chief feels that the project has merit, he makes preliminary designs cost estimates and forwards a request to the Provincial DPU water resources department for consideration. If the department approves the project, it is included in the next fiscal years' budget request. If the project survives and stays in the approved budget it will then be constructed under the direction of the implementation department of the irrigation division or subdivision. Actual implementation can take a considerable length of time.

Apparently the budget does not include general funds for the construction of small projects, which cost less than about Rp. 10×10^6. Only 7 percent of the annual budget is allocated to emergencies.

B.2.4. Constraints to Project Operation

There are many constraints today in the Semarang area to complete the implementation of irrigation. Many of these areas are being worked on and in due time many improvements will be made. The major constraints at this time appear to be as given in the following.

1. Lack of horizontal and vertical control
2. Poor surveying techniques
3. Getting the tertiary system now being executed to work and accepted by the farmers.
4. Development of a reasonably efficient operation and maintenance program for project facilities.
5. Government's policy giving a very high percentage of the total Public Work's budget for capital construction.
6. Adequate field drainage facilities (flood control is assumed to be adequate in future).
7. Inadequate canal capacities for intensive agriculture.

B.3. DEVELOPMENT POTENTIAL

B.3.1. Cropping Pattern

B.3.1.a. General

The cropping system must have a potential for increased cropping intensity. The estimated potential for intensification must be based upon knowledge of the relation between the environment and the crop intensification potential of the agroclimate regions. The extent to which the potential for crop intensification is estimated depends upon how well the relationship between management and environmental factors has been defined. The estimate of the crop intensification potential of a region also depends on the extent to which the environmental factor can be specified.

Intensification of cropping systems for rainfed or irrigated paddy rice primarily involves the addition of crops to the sequence. In the Tuntang and Jragung service areas a combination of cropping patterns that are adaptable to the environment are envisaged. The systems are biologically suited to the environment, however, it is believed that there will be resource and management conflicts and it will require 5 to 10 years to overcome those conflicts. Farmers will make modification of cropping patterns and their management, particularly the timing of operations, which are telltale indications of the resource conflicts.

A combination of methods for stratifying recommendations for project implementation is required for the varying environment in the service area. The main goals of the proposed cropping patterns are to increase cropping intensities, make more efficient use of resources that are available, increase yields, and thereby improve the way of life of the people.

Inspite of the relatively high benefit-cost ratios, as revealed by the BIMAS Program, the operating surplus (net farm income minus family living allowance) is likely to be negative for the smallest farms. The approach emphasizes profitability, but it is the farmer's liquidity position which ultimately determines his fertilizer use. A cropping system approach is hopefully better for the small farmer than a commodity approach in a production program, even though it will invite new institutional problems.

By smoothing out demand for production credit over the year, multiple crops may reduce interest costs for individual crops by increasing total returns per unit of saving.

B.3.1.b. Predicted Land Use

The predicted land use for future condition for the Tuntang-Jragung irrigation service area is as follows:

	Percent of Area				
	1979	1987	1990	2000	2020
Surjan	14.8	14	12	5	5
1 Rice Crop	46.4	43	10	-	-
1 Rice Crop + Palawija	4.5	5	-	-	-
2 Rice Crops	20.1	18	15	0	0
2½ Rice Crops	0	5	10	14	14
2 Rice Crops + Palawija	1.3	2	5	10	10
3 Rice Crops	12.9	13	48	71	71
TOTAL	100	100	100	100	100

B.3.1.c. Future Cropping Patterns

The cropping patterns likely to be adopted are 3 crops of rice, 2½ crops of rice and 2 crops of rice and one mixed palawija crop in one year. The productive base of a cropping system is plant growth which is influenced by environment and management. When determining cropping patters a number of factors must be considered, namely:

- the desires of the farmers
- the maximization of net farm income
- the ability of the project to provide adequate water and timely delivery
- the conflict between the adoption of new technology and other goals
- the lack of adequate knowledge or managerial skill of intended users
- the profit potentials needed to overcome value conflict, managerial weakness or institutional conflict
- the agreement between the cropping systems and sound agricultural practices
- the closure of canals for maintenance
- the capacity of the institutional system to deliver full profit incentives and knowledge of the incentives to the intended users
- the capability of the program and the intended users to exploit the economic potential of appropriately adapted technologies, etc.

With adequate water for year-round irrigation, the farming systems will be based either on continuous rice (3 to 4 crops a year) or continuous high value crops. Continuous rice will be the most commonly accepted practice. Land preparation in the paddy required lower power inputs than that for upland crops in a paddy field. Irrigation to achieve standing water in the paddy requires far less precision than the more exacting irrigation demands of an upland crop in a clay soil. It may be true in the dry season that less water would be needed for an upland crop, but the conversion of puddled clay soil to an upland condition, the construction of ridges or raised beds and furrows for in-paddy drainage and dead level irrigation, and the higher fertilizer and insecticide inputs required for the upland crop make continuous lowland rice more attractive unless water availability is the primary limiting factor.

With increasing reliability of adequate water delivery for year-round irrigation, it is anticipated that the majority of the farmers (about 75 percent) will grow three crops of rice a year, not more than 10 percent of the farmers will be raising 2 crops of rice and a palawija and 15 percent will be growing 2.5 crops per year. Surjan will still occupy about 5 percent of the total cultivatable land reducing the above values to 71, 10 and 14 percent when applied to the net irrigable project area (36,781 ha).

It is anticipated that during the first few years of the project the complete adoption or the use of HYV during the wet season is unlikely. With increasing availability of HYV seed and with more of it grown during the wet season there should be water available for the growing of the mixed palawija after the dry season rice crop. It is believed that about 5 percent of the farmers will continue to grow local varieties, however, this practice will rapidly become obsolete. The cropping patterns are presented in Figure B-4.

The main features of the cropping pattern are listed below.

1. Nursery - Rice seedlings are raised in a nursery for 20 days prior to transplanting. Nursery activities will coincide with land preparation.

2. Land Preparation - A 25 to 30-day puddling and land preparation period is provided for wet season rice. Land preparation period is staggered to utilize labor resource. A 20-day land preparation period is provided for the dry season rice crop and 20 days for the palawija crop. Water for land preparation will be provided on a rotational basis.

3. Transplanting - It will follow land preparation and will be staggered to more efficiently utilize labor. The staggering of transplanting will follow the rotational application of land preparation water.

4. Growing Period - A growing period of 90 days from transplanting to harvesting for HYV (IR 28, IR 30, IR 34, and IR 36) during the wet and 85 days during the dry seasons is provided. A 2½-month growing period is provided for the mixed palawija crop.

5. Ripening - Irrigation water will not be required during the last 15 days of the growing period in the wet season and 10 days on the dry season when the grain is field drying and ripening, therefore, irrigation can be cut-off during that time.

6. Harvesting - Ten days have been allocated for harvesting in most rotations.

B.3.1.d. Constraints to Future Cropping Patterns

With reliable irrigation and integrated water management it is theoretically possible for farmers to raise four HYV rice crops a year, although 3 crops is a more practical average. It is believed that the cropping pattern over a large area will be limited by various constraints. Some of these constraints are:

1. Human Factor - Some farmers may not grow a palawija crop after two successful rice crops as they may believe that they have an adequate food and cash supply until the next rice crop. The farmers generally will not adhere to a definite crop cycle (fixed starting date) once an assured irrigation supply is available, they will probably change to a staggered cropping pattern.

2. Land Preparation - Where draft animals are available, and if the farmer can afford to hire them, farmers prefer to prepare land for rice using animals rather than manual labor. Availability of draft animals is foreseen as a major constraint to concentrated land

preparation in a short period of time. To adequately allocate the work load for available animals it is suggested that the service area be divided into rotational blocks or areas. The land preparation in each block or area be concentrated in a 30-day period thereby permitting the available animals for hire to be utilized in a larger area.

3. Manual Labor - Even though labor is relatively plentifull, a spread of activities should be provided to ensure that adequate labor is available, especially for transplanting and harvesting.

4. Varietal Preference - Some local varieties will continue to be grown in the wet season, even though they have lower yields than the HYV. Local varieties have specific uses for confectionary and festive occasions and usually command a higher price in the market than HYV.

5. Seed Supplies - Shortage or delivery delays of quality HYV seed and distribution problems will limit the area of HYV grown.

6. Inadequate Water Management - This is the primary constraint on agricultural production. Water availability is important, but it is only one input necessary for sustained agriculture. The proper management of water on the farm cannot be neglected without disappointing results.

7. Commencement of Irrigation Season - Delivery of water for beginning the irrigation season should coincide with the increasing availability of water from storage, increased rainfall, canal maintenance and the recommended time for land preparation.

B.3.1.e. Delay in the Adoption of Cropping Patterns

When a partially irrigated or rainfed area is converted into a fully multiple cropped irrigated area a dealy in the acceptance and adoption of a new cropping pattern can be anticipated. Therefore, a step-by-step progressive implementation or adoption of the cropping is assumed. The assumptions are:

1. By the end of the third dry season about five percent of the farmers will plant a mixed palawija crop following dry season rice.

2. Fields already being cultivated to rice are expected to grow rice in the first irrigation season. However, availability of adequate water during the first or second dry season may be short since the reservoirs may not have had a chance to fill and all of the tertiary canals may not be functioning. The availability of water and quality of irrigation may be questioned. Therefore, rice yields during the first irrigation season may be relatively low or at least equal to rainfed rice.

3. Fields currently cultivated to rice are expected to grow rice during the first dry season.

4. Dry farming will be more complicated to convert to irrigated farming than rainfed farming.

B.3.2. Yield Projections

Future yields are projected for two cases, future without project and future with project.

Without project yields are expected to moderately increase from present average yields due to the introduction of new and improved crop varieties and continued support from BIMAS and INMAS type programs. For without project conditions during the dry season in the Tuntang service area there is sufficient water to produce a dry season rice crop on about 44 percent of the irrigable area. Whereas in the Jragung service area a dry season rice crop is produced on only 13 percent of the area. It is anticipated that approximately 15 percent of the farmers will grow a palawija crop following wet season rice and about 15 percent of the area will be in surjan.

Historically, past yields for Demak Regency had a linear trend; this trend is depicted in Figure B-3. Yields prior to 1971 were not used in the analysis because they are very low and the influence of high yielding varieties and fertilizer is not evident. Projected rice yields for without project conditions are tabulated below and are also presented in Figure B-3.

Rough Rice, t/ha

Year	Wet	Dry
1987	3.4	3.2
2000	3.8	3.6
2020	4.1	3.9

Palawija Yields, t/ha

Year	1987	2000	2020
Maize	1.2	1.5	1.7
Sorghum	1.8	2.3	3.0
Soybeans	0.8	0.9	1.0
Tobacco	0.6	0.6	0.6

'With project yields' are based upon the assumptions that there will be an intensive agricultural development program; an integrated water management program, adequate and timely deliveries of water; available credit; an adequate marketing system; an institutional capability to deliver full project incentives to the farmers; etc. The projected yields are estimated to be:

Rice Yield, t/ha

	1987		2000		2020	
Wet Season	Yield t/ha	% of Area	Yield t/ha	% of Area	Yield t/ha	% of Area
BIMAS Assisted HYV	4.2	60	5.4	90	5.7	100
INMAS Assisted HYV	2.7	20	3.4	10	-	-
Unassisted	1.8	20	-	-	-	-
Average	3.4		5.2		5.7	

With project projected palawaija yields are as follows:

Crop	Yield, t/a 1987	2000	2020
Maize	1.2	1.5	2.0
Sorghum	1.8	2.8	4.0
Soybean	0.8	1.0	1.4
Tobacco	0.7	0.9	0.9

B.3.3. Irrigated Areas

A total area of 36,781 ha is available for irrigation with all but about 3,940 ha already being under irrigation. Present Jratunseluna Project development and rehabilitation plans would upgrade the present system to include tertiary development on all 36,781 ha, including the Grogol West area. Tuntang River flows are presently available to irrigate the entire 25,088 ha located in the service area as soon as the conveyance system is rehabilitated so that water can reach all the tertiary turnouts. Therefore, no additional works are planned for development in the event storage facilities are constructed in the rivers.

The irrigated area shown excludes the Dangi Area of 3,612 ha which is presently irrigated by the Tuntang but is scheduled to be transfered to the Serang River when the storage facility is constructed thereon. In the event storage is not provided on the Serang River, the Dangi area will have to remain a part of the Tuntang area since the area is presently producing nearly three crops of rice a year at a rate of about 4,000 kg per hectare.

The potential service areas for the Tuntang-Jragung Project area are as follows:

Service Areas Development for Irrigation
(hectares)

Jragung Area	
Jragung Right	1,101
Jragung Left	1,011
Pamongan	1,502
Guntur Left	1,554
Guntur Right	383
	7,551
Prauwvaart Area	
West	3,150
East	992
	4,142
Subtotal	11,693
Tuntang	
Glapan East	9,177
Glapan West	9,800
Glapan Setu + Ketitang	2,171
Grogol West	3,940
Subtotal	25,088
Total area	36.781

B.4. IRRIGATION REQUIREMENTS

B.4.1. General

The provision of an adequate water supply for an irrigation project is fundamental to the success of the project. History reveals that projects designed and constructed using the contemporary farm management technology, cropping patters, yields, system efficiency, etc. will be outdated and have insufficient capacity to meet the irrigation requirements 10 years in the future. The design of a system based on 1.0 l/s/ha in 1970 were outdated by 1976 and those being designed for 1.4 l/s/ha today will be under-sized in 1983. Similarly, system designs and storage capacity based on two crops of rice are already outdated and will leave the system without sufficient storage capacity to meet the farmers' present crop water requirements, let alone those of the future and thus will pose a constraint on rice production in Semarang area.

Irrigation requirements are determined by the crops to be grown under local climatic conditions, future cropping patterns and calendar, field water management, and conveyance system operation. The future cropping pattern will be rice orientated. The present area is tripple-cropped to rice on 13 percent of the area. Therefore, any future pattern must include a major portion of the project area on 3 or more rice crops per year. No specific maintenance period is to be allowed for. Maintenance will have to be cycled within the normal operations of the project, primarily in the wet season when demands are low. The Jragung-Tuntang irrigation system cannot afford the luxury of system shut down for annual maintenance since this could cost the project a crop of rice on 35,000 ha.

There are no data on field measurements of crop water requirements nor of system losses in the Jratunseluna Basin. Consequently all irrigation demands are based on the experience of the consultant and his evaluation of the project area.

B.4.2. Potential Evapotranspiration

The potential evapotranspiration (PET) of an area is calculated from locally available climatic data. The Penman combination equation (1963) was the method adopted for use in the Semarang area. It has been used before with reliable results. The equation used has the following form:

$$PET = \frac{\Delta}{\Delta + \gamma}(Rn) + \frac{\gamma}{\Delta + \gamma}(15.36)(1.0 + 0.0062\, U_2)(VPD)$$

Where

$\frac{\Delta}{\Delta + \gamma}$ = weighing parameter for latent heat

$\frac{\gamma}{\Delta + \gamma} = 1 - \frac{\Delta}{\Delta + \gamma}$ = weighing parameter for sensible heat

Rn = net radiation in ly/day

U_2 = windrun at 2.0 m height in km/da

VPD = vapor pressure deficit in mb.

The climatic data inputs are maximum and minimum temperatures, average day time relative humidity, windrun and percent sunshine. Average monthly values for the period 1968 through 1978 were used. The data were from the Semarang M.P.B. Station; elevation 3.0 m M.S.L., location 06° 59' S, 110° 27" E. The wind data in m/s have been adjusted to the 2.0 m height from the recorded height of 7.6 m and converted to km/day by a factor of 32.96. The percent sunshine data are those reported occuring between 0800 and 1600 hours each day. A correction factor to adjust this to a true daily percent sunshine was not available so that the reported data had to be used for the calculation of PET.

The estimated (calculated) average monthly PET values for the Tuntang-Jragung project area are:

January	124.2 mm	July	144.0 mm
February	132.1	August	156.2
March	131.6	September	179.8
April	141.8	October	179.9
May	133.4	November	157.5
June	137.7	December	136.7
		Total annual	1,754.9 mm say 1,755 mm/year

The variation in annual PET values is on the order of 15 percent (±). The monthly variation in PET from the monthly mean will exceed 25 percent.

B.4.3. Evapotranspiration

The evapotranspiration rate of a crop is estimated by multiplying the PET value by a crop coefficient (Kc) which is determined from field testing. In the case of rice, the Kc value includes the evaporation from the crop and the underlying water surface. Initially after transplanting the evaporative demand of the paddy water surface is high and that of the rice plant low. As the plant grows and shades the water surface, the crop evaporative demand increases rapidly until full canopy is achieved and thereafter tends to level out while that from the shaded water decreases rapidly. The values of the crop coefficient vary from 1.0 at transplant to 1.15 in the reproductive stage with an average of 1.10 during the main growing period. The value of Kc decreases as the grain fills and ripens. Irrigation is suspended prior to harvest by 10 to 15 days depending on the season. The same Kc values were used in the wet and dry seasons. The higher values recommended by the Directorate of Irrigation, Bandung for the dry season are believed to include climatic affects which are actual a part of the PET estimate. The PET demand estimate already shows a significant increase in the dry season.

To facilitate the computation of irrigation demands for use in the computer model, an area factor was introduced into the Kc value so that a single area could be used for all months and not the variable areas which would be actually in production at any given time. Therefore, the values used have not been shown as they would cause confusion by not matching the standard values often used by others.

B.4.4. Land Preparation

Additional water is required for the land preparation stage to saturate the soil profile that allows the farmer to more easily work his land into an acceptable seed-bed. In general, under intensified management, the land is plowed by hand, puddled by foot and leveled by a team of draft animals. This takes 10 to 20 days depending on the labor supply and the individual farmer. Soil that is allowed to dry out for a period of two months or more will require 250 mm of water to fill the voids, cracks, etc. and bring the soil to saturation. The corresponding amounts of water for periods of 1 to 2 months, 20 to 30 days, and 10 to 20 days will be 200 mm, 150 mm and 100 mm, respectively. This saturation requirement also includes 50 mm or so to raise the paddy water surface to transplanting depth. Therefore, as the turn-around period between crops shortens, the saturation requirement is reduced.

As soon as the paddy is flooded, free water moves down and out of the paddy. This is referred to as a deep percolation loss which the farmer has little control over. Measured values (NEDECO 1973) have ranged from 0.5 mm/day to over 2 mm/day. The average value for the Jragung area was estimated at 1.5 mm/day and that for the Tuntang area at 1.0 mm/day giving a combined average of 1.13 mm/day. As with the saturation requirement the shortening of the turn-around time between crops and the length of the land preparation period reduce the total crop water requirement of rice.

Presently, land preparation periods vary in the project area from 1 - 3 days to periods of up to 60 days. Average requirements appear to be on the order of 10 days/bau or 20 days/hectare.

B.4.5. Crop Calendar

The crop calendar shows the planting dates, length of growing season, irrigation suspension schedule, harvest period etc. The calendar may show the season of individual crops or it can show a series of crops grown in a fixed rotation. A crop calendar was developed for a series of rotations. The Tuntang-Jragung project area has been studied based on October and November starting dates, some of which are shown in Figure B-4. The calendars shown therein are for a single crop of rice, 2 crops of rice per year, 5 crops of rice in two years, 3 crops of rice and 4 crops of rice per year.

Although 4 crops of rice are not presently grown in the area, many farmers will adopt this system provided the constraints on water and fertilizer are removed. Four rice crops per year are presently being produced by farmers in other Southeast Asian areas so it is only a matter of time until the extension people will also introduce it to the Indonesian farmer.

B.4.6. Crop Water Requirement

The crop water requirement is the sum of the evaporative demand, land preparation requirement and percolation loss. The amount of water required to produce a crop of rice varies with the land use intensity as mentioned above. Reductions in turn-around time between crops and shortening the land preparation period and the growing season (irrigation period) combine to reduce the per crop requirements as shown below for an October start:

Crop Intensity	Annual CWR-mm	Per Crop CWR-mm
1 - crop/year	913.1	913
2 - crop/year	1,667.2	834
2½ - crop/year	2,033.9	814
3 - crop/year	2,384.2	795
4 - crop/year	2,439.2	610

The above indicated that it only requires 55 mm more water to produce 4-rice crops per year than three. It also shows a net saving of 300 mm on a crop of rice when the land use intensity is increased to 4 crops per year and 200 mmm on a crop when going from 2 to 4 crops.

Based on the above plus the need for Indonesia to produce as much rice as possible to feed its growing population, from a slowly decreasing area of paddy in Java will require new technology. If the project is not sized to its future potential now, this potential cannot be reached in the future.

B.4.7. Cropping Pattern

The future cropping pattern developed herein for future requirements for the Tuntang-Jragung Project area was not the 4-rice crop recommended pattern suggested above but one based on three crops of rice per year to fit a specific operating senario for the proposed Glapan Barrage. This particular senario requires any residual storage in the reservoir to be dumped in October to allow the reservoir to completely drain. Therefore, when the rains come and the river rises, all flows will be passed immediately through the reservoir thereby reducing silt accumulation in the reservoir. This operating mode places a severe restriction on the cropping pattern that can be adopted to the project. It requires that the October irrigation demands be kept as low as possible. This requirement eliminates the possibility of raising 4 crops of rice per year as the 4-crop system requires rather uniform releases throughout the year. In order to achieve the minimum demand in October, the starting date for the various rice rotations was moved to November. The turn around time was reduced to 20 days which includes the harvest period. As with the 4-crop system, a uniform 3-rice crop system will not be practical with the requirement of a low October demand. The recommended cropping pattern that is consistent with the reservoir operation and the local agricultural system was estimated to be 75 percent in 3 rice crops per year, 5 percent in 2½ crops per year (5 crops in 2 years) and 10 percent in 2 rice crops per year followed by an irrigated upland crop (Palawija). This pattern also acknowledges that not all farmers will grow 3 crops of rice a year.

The average monthly project crop water requirements based on the above cropping pattern were estimated as given below:

January	179.8 mm	July	236.0 mm
February	138.1	August	192.6
March	274.6	September	200.7
April	181.7	October	65.1
May	181.8	November	328.2
June	150.1	December	179.4
		TOTAL	2,299.1 mm

B.4.8. Effective Rainfall

Effective rainfall is defined as that portion of the total rainfall occurring over the project area that is used to meet the crop water requirement. Under the present system of operation the wet season use of rainfall to meet the crop water requirement is very low. The Tuntang Project operates on a continuous flow basis during the wet season as soon as the river flows reach canal capacities. The water flows into the project area at full canal capacity whether the water is required or not. The canal capacities are reduced after each turn-out so that water can not be carried down the canal to a waste-way but in general, must be turned out into the paddies where it makes its way to the drains less whatever is used by the crop. Any rainfall occurring under such conditions also flows to the drain and is not used. The paddies are also constructed with low bunds with many of them only 5 - 8 cm high so that storage of rainfall, even temporary, is not a factor. Only during periods where the paddies are not full and no water is moving between paddies can rainfall help to meet the crop water requirement.

In order to reduce the demand on a reservoir during the wet season and to allow for increased storage, rotation irrigation should be practiced. Paddies should only be filled to a prescribed depth of 5 to 7 cm at each irrigation cycle, and flash boards installed in the bunds to allow additional water to be stored to a depth of 10 to 15 cm before it overflows the flash boards and out of the project. As long as rainfall holds the paddy water level above a depth of 1 or 2 cm, irrigation is not required. All rainfall that did not overflow the flash boards would then be affective in meeting the crop water requirements.

Based on detailed daily rainfall and irrigation studies made by the Consultant on other projects, the following equation may be used to estimate effective rainfall (RE) when rotational irrigation is used and affective storage allowed;

$$RE = 1.8 (RF)^{0.8}$$

Where RF = Natural rainfall.

The operation study model automatically computes the effective rainfall from the historic rainfall pattern used for the entire project area. Therefore, estimates of effective rainfall are not shown herein.

B.4.9. Irrigation Demand

The irrigation demand is the crop water requirement less any effective rainfall plus the field application losses plus the transmission (conveyance) and operational losses. System loss data are not available for the project area. Visual indications coupled with some rough calculations and judgement would indicate wet season efficiencies in the Tuntang System on order of 35 percent (i.e., 65 percent of all water diverted is wasted). Dry season efficiencies with the rediversion of drainwater (return flow) back into the paddies could be as high as 80 - 85 percent. With future project conditions and a more uniform availability of storage water the dry season field application losses will be about 10 percent and conveyance system losses about 20 percent which gives an overall dry season loss of 27.5 percent. Wet season losses in the future using rotation irrigation are estimated at 47.5 percent. Part of the high loss rates will be due to excess of flow available for diversion and the inability of extension to convince the farmer to use rainfall instead of irrigation. The estimated monthly efficiency factors for the Tuntang-Jragung project area are:

January	0.525	July	0.600
February	0.525	August	0.720
March	0.525	September	0.720
April	0.525	October	0.720
May	0.525	November	0.600
June	0.600	December	0.525

The irrigation demands are computed in the computer model and are given in the printout results. The demand varies from year to year and the mode of operation to some extent.

B.5. SYSTEM CONSTRAINTS TO INTENSIFIED IRRIGATION

If it is assumed that the development plan is executed, the O & M has been alleviated, the tertiary development program is completed, and extension and assistance programs are a reality, then the only constraint to intensified irrigation of rice is the low system conveyance capacities which range from 0.8 to 1.1 l/s/ha over most of the Tuntang system. To increase the canal carrying capacity and also to improve and maintain all weather roads will require a large amount of money. The cost of increasing the carrying capacity to various level is shown on Figure B-5. No recommendation is made at this time although generalized recommendations made by Consultants range from 1.4 to 1.65 l/s/ha. Some of the problems associated with determining a recommendation are given in the next section. The final recommendation will also rest with the decision as to whether storage will be available

B.6. PROBLEMS ASSOCIATED WITH INCREASING CONVEYANCE SYSTEM CAPACITIES

The entire Tuntang-Jragung Project area has been completely rehabilitated on paper. In actuality only about 40-45 percent of the area has water delivered to it and it all lies within Tuntang area. The cropping intensity on the area actually served is quite high averaging about 1.75 crops/year/ha. In addition, the DPU have instituted a massive program to construct the tertiary or on-form distribution systems on 80,000 ha in the Jratunseluna Basin. The program was scheduled for rapid completion but has proved to be too ambitious for this project. Those areas already constructed are in general not operational and the farmers often bypass or cut across the system to get water where it is required.

There are many reasons which make the systems non-operational. These are the design mistakes, construction mistakes, in-adequate topography and surveying, lack of knowledge of the farmer's needs and many other items. This problem has been compounded by the lack of proper operation and maintenance.

All irrigation schemes have many start-up problems due to design and construction errors. This is normal because it is much easier to field adjust the problems after the start-up than to spend large sum of money to adequately survey an area at a large scale to obtain an accurate topography. Rice paddies are even more difficult because the normal contour lines do not work in paddies since each paddy is essentially dead level. Designs would require topography with each paddy shown and necessary spot elevations given. Field surveys often have spot elevations made on the paddy bunds and the resulting 20-30 cm error can cause considerable problem when placed on maps. Designs based on this type of the data will often not function or will leave many areas un-serviced.

The government policy has been to expend large sums of money for capital construction and very little on maintenance. Much of the maintenance funds are expended on staff and running of offices with little left for actual maintenance, supplies and equipment. The World Bank and the DPU have not adequately funded the rehabilitation of the Tuntang/Jragung area during the start-up operations. Therefore, nothing has been done in the field that will allow water to be distributed, particularly the areas farthest from the source of water. The NEDECO O & M team has shown that most areas can be made operational but it requires the expenditure of money and labour. Field deficiencies can often be corrected by minor construction or changes, cleaning, staffing and training. It is assumed that the Bank and the DPU will provide the funding necessary to get the project operational by 1985-87 with the assistance of NEDECO or other consultants.

The drainage and flooding of the low areas will be completed in the next year or two depending on a variety of factors affecting construction progress. The same is true with the on-farm development, although this will take much longer to accomplish.

When the project is completely operational, which means water can be delivered to all parts of the project, the conveyance system will not have a uniform carrying capacity for the area or sub areas being served. The unit carrying capacities of various reaches of the system vary from 0.76 l/s/ha to about 1.4 l/s/ha and average about 1.04 l/s/ha. The term carrying capacity is used since the often used term design requirement is not applicable as the service areas have been changed since the design and construction phase. There also appears to be the possibility that an error was made in the design criteria used on the Glapan Barat Canal and the conveyance system.

The available conveyance capacity becomes more critical as the intensity of irrigation and crop production increase. The increase in intensity can occur with both run-of-river and with upstream storage. It is much more critical with storage facilities involved than for the run-of-river. This can be examplified by the land preparation period. At the present time land preparation activities are dragged out over a period of 5 months or so (October through February) extending the crop season for the first crop into June. The major reason for this is the inability of the system to deliver large quantities of water in a short time. Therefore, rainfall becomes a more important item in meeting the land preparation and crop requirements. A carrying capacity of 1.65 l/s/ha would allow the entire crop to be transplanted in 80 days and two-thirds of it in 55 days rather than the 150 to 160-day period now used. This would allow two crops of rice to be grown in the same time from now used for a single crop. Not all areas have this problem. There are areas in the Tuntang Project, particularly on the right bank, that produce two and three crops of rice a year. These are all close to the available water supply.

Increasing the carrying capacity does not solve all problems. The increased carrying capacity costs a lot of money since it usually requires considerable changes in the canal cross-sectional area, road maintenance, and structures. The larger the carrying capacity the less time the canal will operate at full capacity. In dry years it may only be 60 days or so and in wet years 30 days or less. This is expensive. The increased capacity also means that the system operates with the water surface checked up to get the necessary discharge at the turnouts. This means the water moves at a lower velocity that for full design capacity, giving suspended sediment more chance to drop out and become adhered to the canal sides and bottom. Subsequent increases in velocity with increased discharge rates are not enough to dislodge the very cohesive clays and silts that make up the Jratunseluna sediments. Therefore, cleaning costs increase. The design criteria for cohesive sediment are not well known and those derived for sandy sediments do not apply fully.

Rotation irrigation can be used to operate canals at full capacity. This means that there are periods of time when the canal will have no flow. A dewatered canal will have problems with the canal sides sloughing-in due to hydrostatic pressures. This causes increased maintenance. Standing slack water would prevent the sloughing but would cause sediment deposition.

Run-of-river systems can always carry full capacity when the water is available in the river whether there is a demand for it or not. The extra water must be disposed of using turnouts or waste-ways at drains or run out into the paddies and hence into the drains. This increases the drainage requirement of the system and hence the cost. The discharge of full canal capacity into the system plus discharge requirements for large rainfalls increase the drainage requirements to 7 l/s/ha or higher. Sediment is still a problem in that if it is moved through the system it must then drop in the paddies, or it will deposit in the drains. The deposition rate in the drain will be less than that in the irrigation canals but still it can be a major problem and increase maintenance cost considerably.

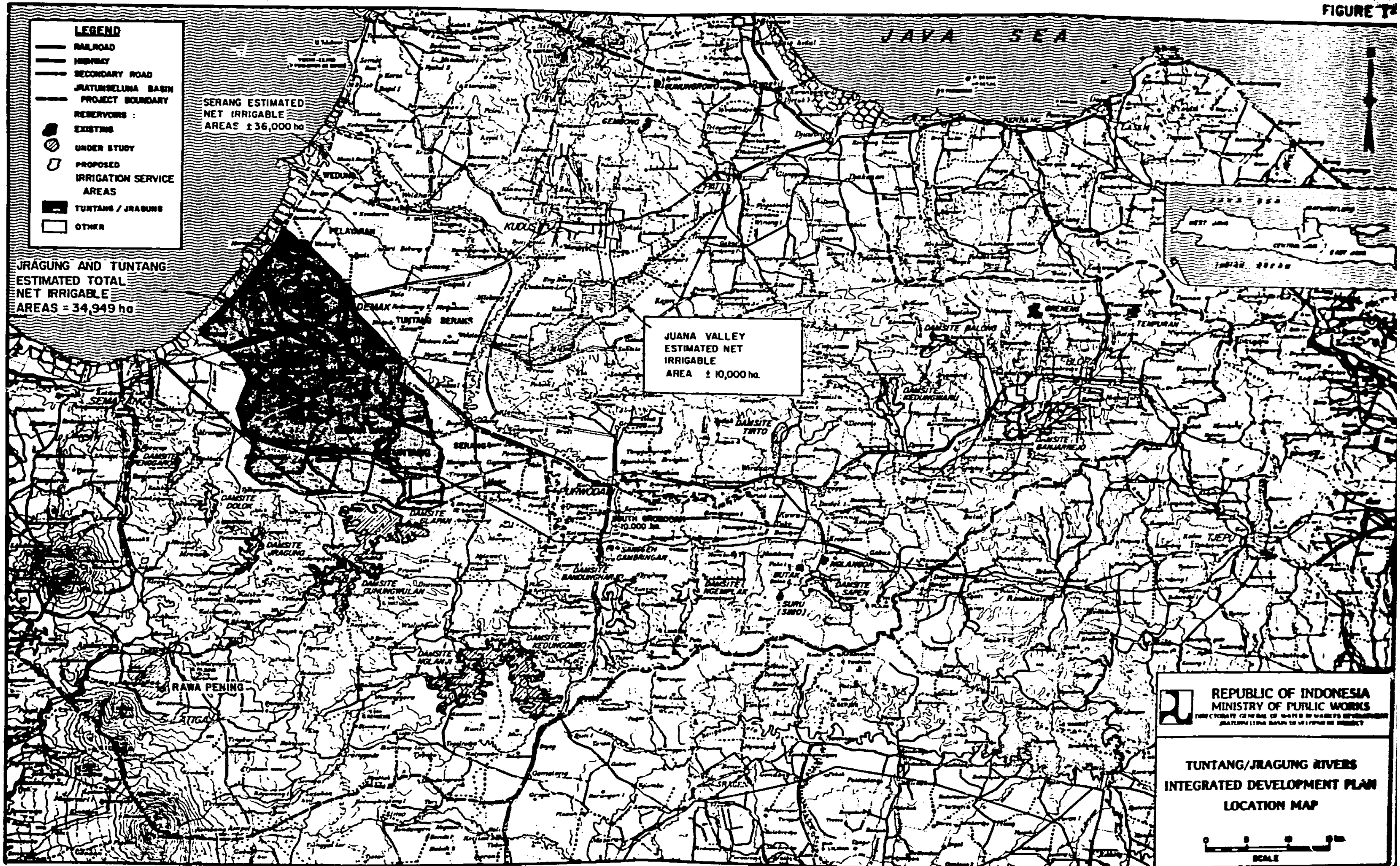
Measured suspended sediment rates in the conveyance system range from 40 to 17,600 mg/l. The high values occur only during floods but normal wet season values are very high also. The low flow values of 40-500 mg/l are not a major problem. The normal sediment extractors designed for fine sands do not work efficiently for the cohesive sediments as in the Jratunseluna Basin.

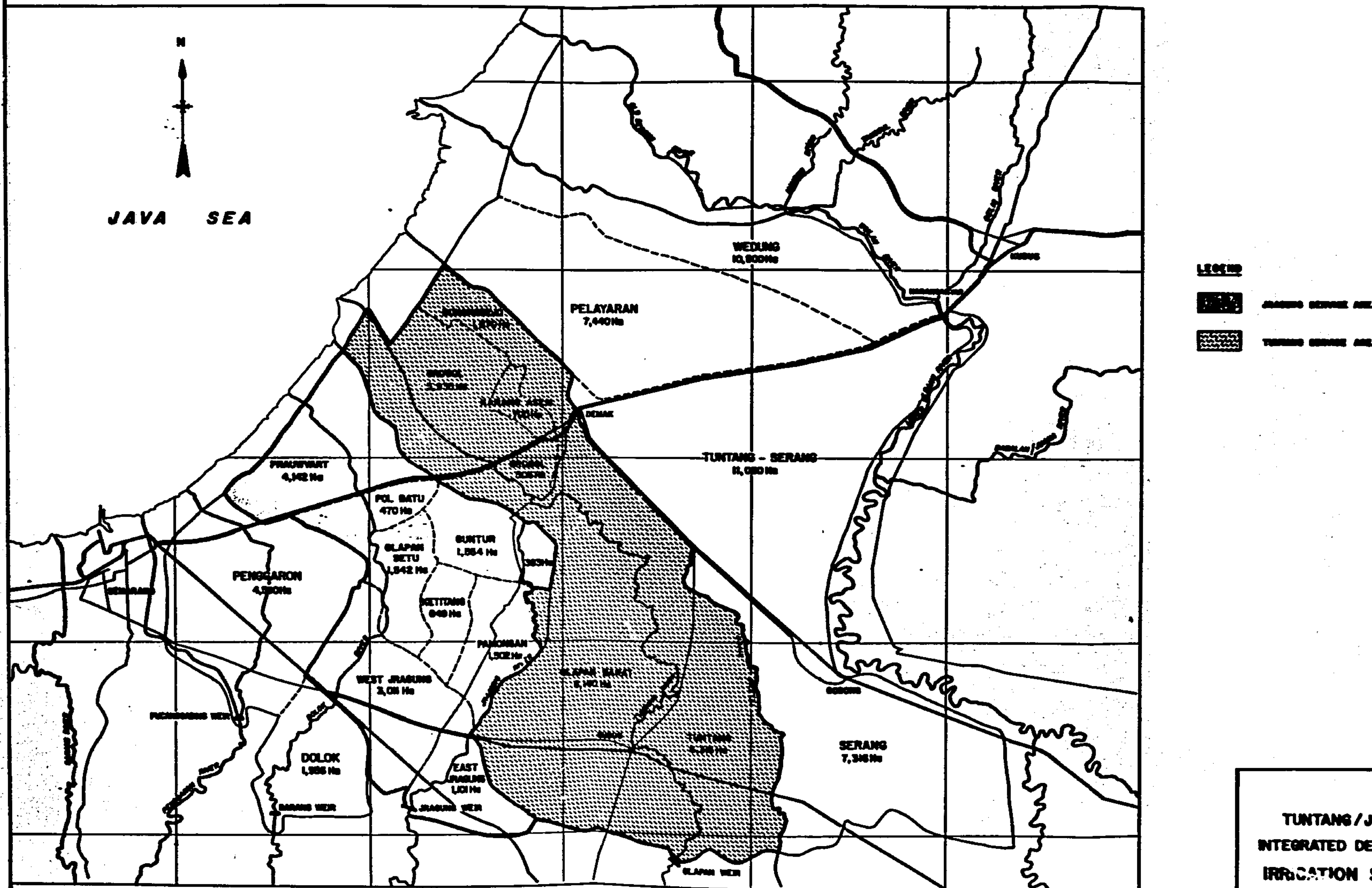
The above discussion points out the many problem involved in getting the Tuntang/Jragung conveyance system to operate properly. No attempt is made at this time to quantify these problems as it is far beyond the scope of this study to solve these very complicated problems. To assist in the planning, cost estimates have been made for increasing the carrying capacity from the present level to 1.25, 1.4 and 1.65 l/s/ha. In all probability, the inclusion of storage will require that the conveyance system capacity be increased to some point in the 1.4 to 1.65 l/s/ha for the main conveyance system. The exact value will have to be determined in more detailed studies. A major item in the cost of increasing the conveyance capacity is the cost of an all-weather service road which must either be added or replaced when the canal banks are raised. This road is vital for the operation and maintenance of the system.

BIBLIOGRAPHY

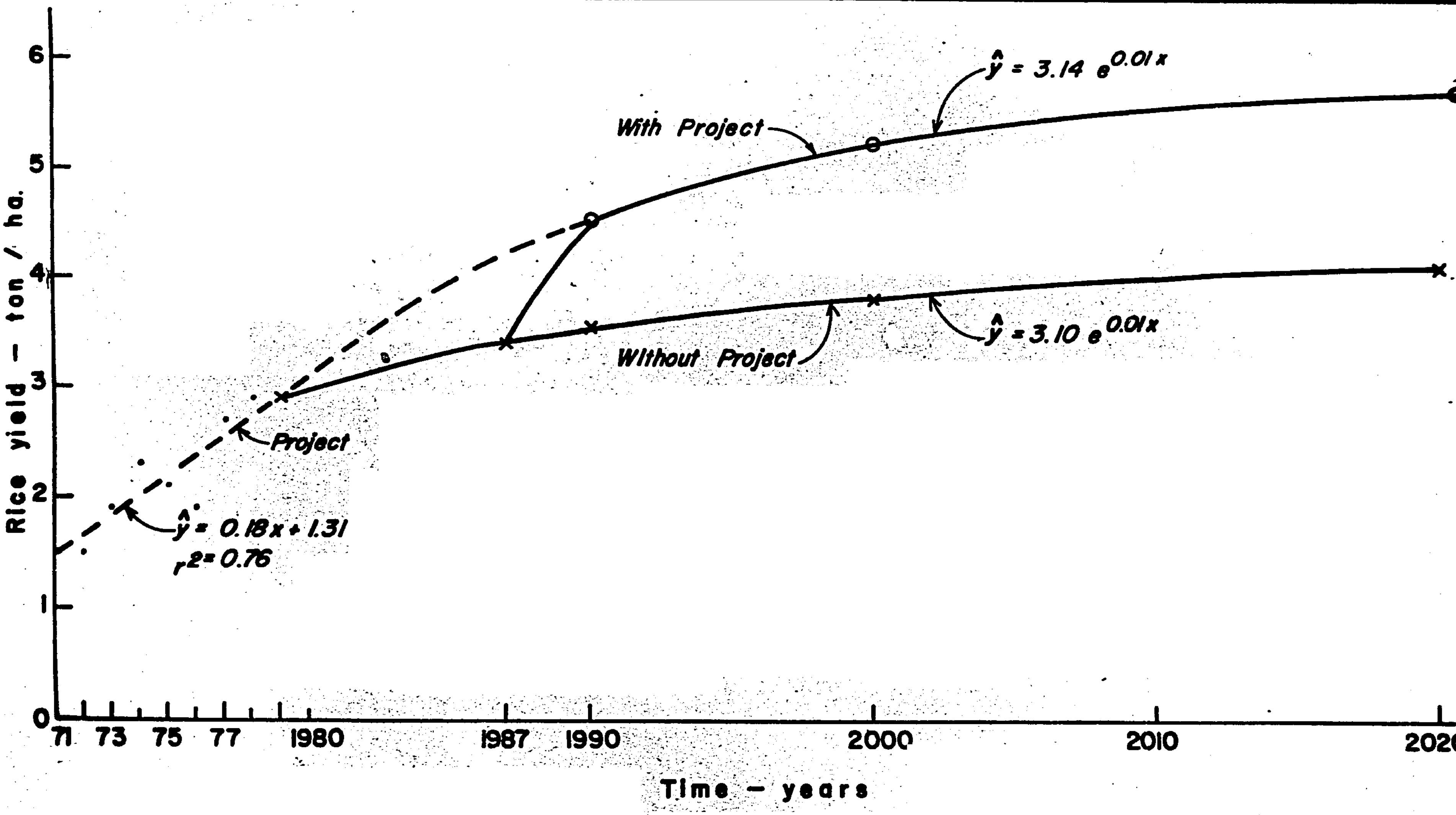
No.	Title
1.	Bogor Agricultural University. Laporan Survei Tanah, Daerah Irrigasi Tuntang. 1972.
2.	NEDECO. Jratunseluna Basin Development Plan - Supporting Report VIII - Salinity Aspects. July 1973.
3.	PRC/ECI. Upgraded Feasibility Report Jragung Dam Project. December 1976
4.	PRC/ECI. Jragung Dam Project - Final Design Report. April 1979.
5.	NEDECO. Progress Report. September 1979.
6.	NEDECO. Jratunseluna Basin Development Plan Feasibility Study Water Resources Development Jragung, Dolok and Penggaron Basin Vol. 1. December 1971.
7.	PRC/ECI. Tuntang/Jragung Rivers Basins Integrated Development Plan. Appendix A - Part I. May 1980.

FIGURE I-2


LEGEND
RAILROAD
HIGHWAY
SECONDARY ROAD
JRATUNSELUNA BASIN PROJECT BOUNDARY
RESERVOIRS :
EXISTING
UNDER STUDY
PROPOSED
IRRIGATION SERVICE AREAS
TUNTANG / JRAGUNG
OTHER
JAVA SEA
SERANG ESTIMATED NET IRRIGABLE AREAS ±36,000 ha
JRAGUNG AND TUNTANG ESTIMATED TOTAL NET IRRIGABLE AREAS = 34,949 ha
JUANA VALLEY ESTIMATED NET IRRIGABLE AREA ± 10,000 ha.
KUDUS
DEMAK
BLORA
SERANG
PURWODADI
DAMSITE TIRTO
DAMSITE BANJAREJO
DAMSITE KEDUNGWARU
DAMSITE DOLOK
DAMSITE JRAGUNG
DAMSITE GLAPAN
DAMSITE GUNUNGWULAN
DAMSITE NGLANJI
DAMSITE KEDUNGOMBO
DAMSITE BANDUNGHARJO
DAMSITE NGEMPLAK
DAMSITE SAPEN
DAMSITE BALONG
RAWA PENING
SEMARANG
TJEPU
REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS
TUNTANG/JRAGUNG RIVERS
INTEGRATED DEVELOPMENT PLAN
LOCATION MAP
SCALE



TUNTANG / JRAGUNG RIVERS
INTEGRATED DEVELOPMENT PLAN
IRRIGATION SERVICE AREAS

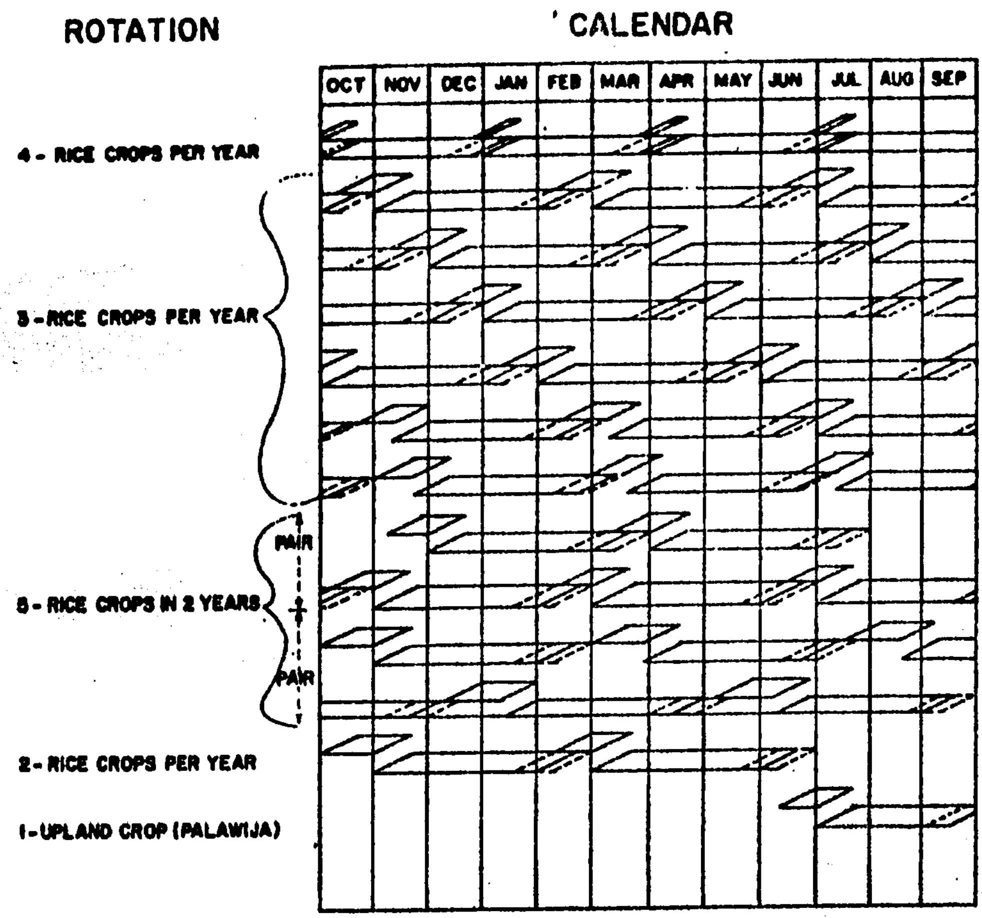


PRC ENGINEERING CONSULTANTS, INC.

TUNTANG / JRAGUNG RIVERS
INTEGRATED DEVELOPMENT PLAN

RICE YIELD PROJECTION

FIGURE B-1

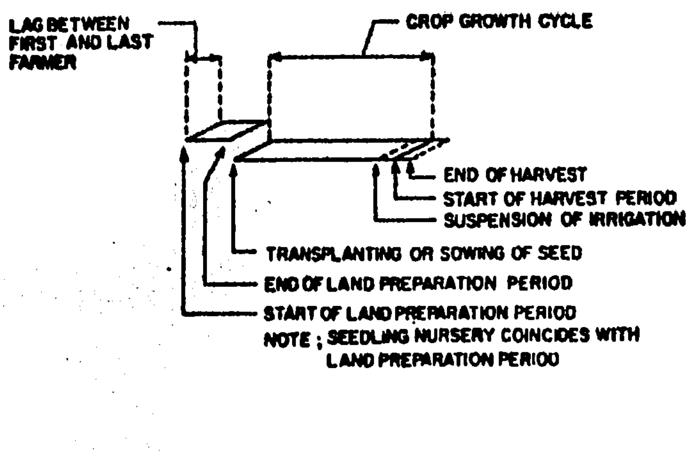


NOTES

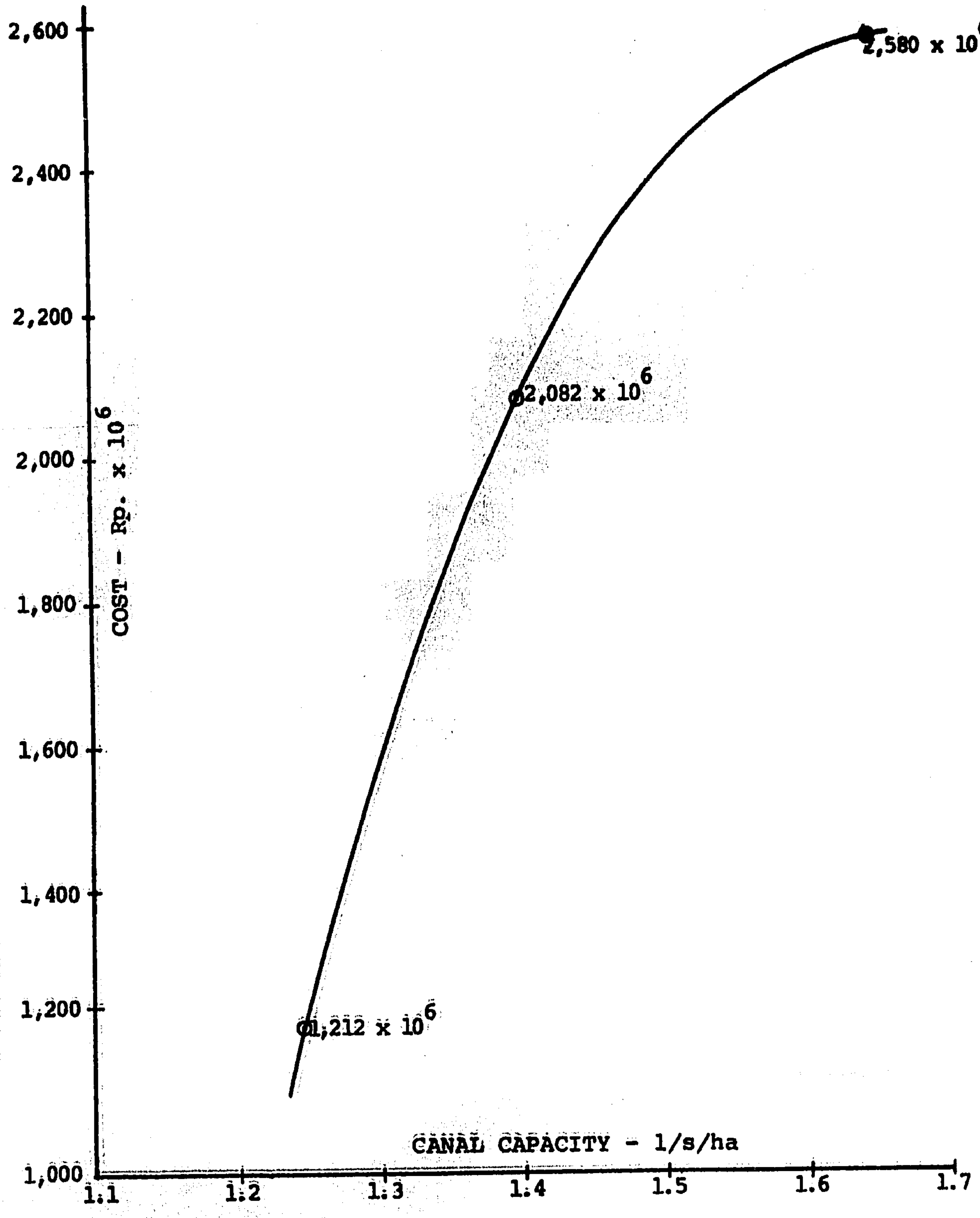
1. RECOMMENDED CROPPING PATTERN FOR JRAGUNG / TUNTANG SERVICE AREA IS AS FOLLOWS:

   3 RICE CROPS PER YEAR — 75 PERCENT OF SERVICE AREA
   5 RICE CROPS IN TWO YEARS — 10 PERCENT OF SERVICE AREA
   2 RICE CROPS AND 1 UPLAND CROP PER YEAR — 15 PERCENT OF SERVICE AREA

2. CROPPING CALENDAR OF 4 RICE CROPS PER YEAR IS PRESENTED AS A POSSIBILITY FOR LIMITED AREAS IN THE FUTURE AND IS FOR INFORMATIONAL PURPOSES ONLY



TUNTANG / JRAGUNG RIVERS
INTEGRATED DEVELOPMENT PLAN
PROPOSED CROPPING CALENDAR



TUNTANG / JRAGUNG RIVERS
INTEGRATED DEVELOPMENT PLAN

COST COMPARISON OF DIFFERENT CANAL CAPACITIES

PART II

TUNTANG AND RELATED RIVERS BASINS DEVELOPMENT PLAN

APPENDIX B

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TUNTANG AND RELATED RIVERS BASINS
DEVELOPMENT PLAN

APPENDIX B - PART II

AGRICULTURE AND IRRIGATION

B.1. GENERAL

The purpose of this part of the appendix is to present results of the study made of the existing irrigation and agricultural practices in three designated areas, namely: (1) Penggaron-Dolok, (2) Lower and Middle Lusi River, and (3) Juana Valley. These three areas are envisioned as irrigation service areas in the "Tuntang and Related Rivers Basins Development Plan". Their potential was presently evaluated at the reconnaissance level. There was not sufficient time to develop detailed data on all three areas. However, previously developed information in the Penggaron-Dolok and Juana Valley areas was reviewed and the data gathered in South Grobogan was adjusted to relate conditions along the Lusi River.

For the development of this part of the plan, cropping patterns are proposed (see Tables B-1, B-2, B-3), other measures needed are recognized and suggestions are given.

The previous studies mentioned above are listed in the bibliography [1, 2, 3].

The potential irrigation service areas in each of the three locations are shown on the map in Figure B-1. Locations of these areas in relation to other portions of the JRATUNSELUNA Basin Project are also shown.

B.2. UPPER LUSI

The Middle and Lower Lusi area was roughly determined by an on-the-ground observation study and use of two types of maps; namely 1) Land Use Maps which were made from aerial photos and 2) maps with 25-m contours. It was divided into 3 sub-divisions: 1) Middle Lusi Right Bank, 2) Lower Lusi Right Bank and 3) Middle Lusi Left Bank. A description of the three areas follows:

1. The Middle Lusi Right Bank area is a fairly narrow band of flat alluvial land on the north side of the river extending from about 4 km east of the Village Kunduran in a westerly direction to 7 km west of Wirosari. The width of the area is quite variable according to the closeness of the foot-hills of the nearby mountains and varies from 0.5 km to 3 or 4 km. The gross area is 5,225 ha and the net irrigable area is 4,000 ha.

2. The main body of the Lower Lusi Right Bank area lies just north of Purwodadi on both sides of the road to Grobogan extending about 5 km to the west and 6 km to the east and to a point just south of Grobogan or 5 km from Purwodadi. A smaller adjacent area lies nearer the river east of this between the streams Nglumpang and Ngantra. The main body is a flat alluvial plain and the smaller area is the part of this except that some low hills occur in the center of the area. The gross area of the Lower Lusi Right Bank is estimated to be 7,500 ha and the net irrigable area is 5,625 ha.

3. The Middle Lusi Left Bank area lies adjacent to the river on the south side beginning at a point 6.5 km east of Wirosari and continuing west for 12 km to a point where it joins the designated South Grobogan study area. It is 5 to 7 km wide extending from the river in a flat alluvial plain to the base of the foothills. The area is bisected by a road from west to east. This road originates on the main road south from Purwodadi. It is also connected to a road north to Wirosari but the bridge over the Lusi on this road has been destroyed by floods. A railroad traverses the south edge of the area about 1 km from the foothills and 2 km south of the road. The principal town of the area is Kradenan. Three or four small ridges running north and south occur in the area but do not completely traverse the width of the area. The gross area is about 7,000 ha and the net irrigable area is 4,200 ha.

The total gross area of the above three subareas then would be 19,725 ha and the net irrigable area would be 13,825 ha.

B.2.1. Soils

Comments on the soils of the area are based on the information given in the South Grobogan report [2] and observations made in the area. A 12,000-acre soil survey in South Grobogan was made by the Faculty of Agriculture of the Padjadjaran University, Bandung.

The area is a high level alluvial flood plain on both sides of the Lusi River. Recent out-washes occur on both sides of the river but are more predominant on the right bank where the calcareous claystone and sandstone hills are much closer to the river and in some places adjacent to it. The soils are vertic and relatively impermeable with no distinct alluvial and illuvial horizons formed due to the high calcium content, prevailing wet and dry conditions, and the relatively high temperatures. All the soils are margalitic and are hard and shrink when dry but sticky and plastic when wet. The clay content varies from 60-90 percent with the majority at the higher levels.

The pH of the soils indicate slight alkalinity. They are relatively high in CEC and base saturation with Ca and Mg ions predominating. This may influence P and K availability in some of the soils. Phosphorus levels are medium to low and potassium low to high with no potassium deficiency symptoms in the rice crop evident. No minor element problems would be expected on these soils.

B.2.1.a. Land Classification

The only information available was the land use maps published by the Department of Internal Affairs, Agrarian Directorate. The categories used in this mapping are broad and not detailed but combined with the soils information mentioned above general land classifications can be made.

As far as rice irrigation is concerned, non-productive areas in the three Lusi River portions varied but averaged 30 percent of the gross area. (See B.2. above). Nonproductive areas included villages, home-yards, fish ponds, cemetaries and the low ridges. The latter are cropped but usually not to rice. If rice has to be grown, it will be on terraces which will be rainfed.

All the irrigable land is suitable for rice with small areas near the river having lighter soil where diversified crops could be grown. Deep percolation losses would be higher along both sides of the river but would not exceed 2.0 mm/day. Losses away from the river would be around 1.0 mm due to the high clay content and the average for the whole area is estimated at 1.25 mm/day. (25 percent of area is adjacent to river). The fertility levels of these soils are discussed in the preceding para B.2.1.

B.2.1.b. Salinity

Salinity is not a problem in the rice growing soils. One active volcanic mud boil exists where salt is deposited on its outer edges. About 35 ha of area is affected in this process. The salt at this boil and several small inactive ones is being mined by using split bamboo poles as evaporation trays.

B.2.2. Crops Grown and Cropping Methods

Detailed comments have been made in Appendix B - Part I and it is not necessary to repeat them here. The following comments apply to the three Lusi River areas in particular. (Middle Lusi Left Bank, Right Bank, and Lower Lusi Right Bank).

B.2.2.a. Rice

It is reported that 72 percent of the area is presently growing HYV rice. This is doubtful from visits to the area although acceptance of HYV resistant to the brown plant hopper is increasing rapidly. The interest has narrowed down with the IR varieties to IR36 which has shown good resistance to BPH, high yield potential and early maturity. With irrigation, IR36 will be widely accepted but its value even under rain-fed conditions as a potential for 2 crops is being recognized by farmers working with PPL (Extension) and BIMAS programs.

Fertilizer use is well accepted in the area with both HYV and LV. All the TSP (Treble Super Phosphate) and some of the urea is applied as a basic dressing at transplanting. The remaining fertilizer is broadcast in two split applications during the first month of growth or in 3 split applications 15, 30 and 50 DAT. No research or extension effort is apparent to prevent nitrogen losses by providing farmers with some method of incorporating the urea 2-4 cm below the soil surface.

Usual rates of fertilizer use in the area are given below: (kg/ha).

HVY	-	200 Urea	(range = 100-350)
		100 TSP	(range = 75-150)
LV	-	125 Urea	(range = 100-175)
		60 TSP	(range = 50- 75)

Rice harvesting is carried out mostly by women. The harvestors' share is usually one-eighth but there are higher shares where the workers assisted in transplanting or weeding. Harvesting is slow and uses labor inefficiently but there are seldom labor shortages. An improvement of the harvest methods would be needed where the turn around time becomes critical when 3 crops of rice are grown under irrigation.

Report of flood damage in the area was not available but it was concluded by examining the topography of the area that natural drainage was adequate except for some small areas in the Northwest-portion of the project area. When flooding does occur, however, it takes some time for the water to drain off the fields.

The present overall rice yield for the area was 2.4 t/ha in 1979 as reported by the District Extension Office in Purwodadi. BIMAS and INMAS have been active in the area with their assistance programs covering about 19 percent of the area. Placing PPL's in the field by the Extension project and with proper back-up personnel is over 70 percent complete in the entire study area and probably higher than that in the rice growing portions.

B.2.2.b. Maize

Maize is the second most important crop grown in the Upper Lusi area. Many of the farmers who grow one crop of rice will grow two crops of maize each year. The dry season crop is planted in June or July after rice. The Labuhan season crop is planted in September and October mixed with another crop. (usually soybeans). This crop gets off in time for the wet season rice crop to be planted.

The maize varieties used are of local origin and the white flint type [Part I of this Appendix, page B-11]. The short time to maturity (75 days) is desired by farmers to fit into their moisture regimes and seasons. There is some interest in improved varieties with higher yield potential through fertilization but their longer time to maturity (85 days) is considered a disadvantage. There is much room to improve the production potential with this crop by a sponsored program and/or extension effort which is presently concentrated solely on rice. As stated in Part I of this appendix, however, with irrigation available, rice will be grown in the dry season and maize would be a catch crop on a limited area.

Land preparation for the dry season maize crop after the rice consists of one ploughing when the land has dried out sufficiently. Small drains through the field are built by manual labor and the maize is planted while subsoil moisture is still present. By the time the labuhan season crop is to be planted, the surface soil is already loose and friable and the sub-surface dry and hard. Under these conditions, the soil would be difficult to plough, so it is loosened by hoeing and left until planting time (after a good rain).

Planting is carried out with the aid of planting sticks. Dry season crop rows are planted 0.8 m apart and plants or hills 0.6 m apart. For labuhan season the spacing is wider at 1 m x 0.8 m to allow space for interplanting of soybeans.

Most farmers use fertilizer with the dry season crop and many use only compost with the labuhan and wet season crops. When used, the fertilizer is applied as a basal dressing. A common rate is 100 kg/ha urea plus 50 kg/ha TSP.

Weeds are controlled with hand weeding and hoeing which helps loosen the surface soil. Insecticides are rarely used and insect pests are normally not a serious problem. The local corn varieties are resistant to downy mildew and most diseases of the tropics but have occasional damage in the wet months.

Maize is harvested by hand when mature but still containing about 25 percent moisture. It is shelled and sun dried in farm compounds.

B.2.2.c. Soybeans

Soybeans are a popular crop in this area with most farmers growing a crop in the labuan season. They are interplanted with maize after the first good rain at the end of the dry season. This occurs in September or October. The land has been prepared for maize as described above. The soybeans are planted after maize emergence with planting sticks in 0.2 m to 0.25 m squares covering the area between maize hills or plants.

In the early growth stages, rains may be infrequent but the plants seldom suffer moisture stress because of their low water requirement. At later growth stages with greater water requirements (Nov. - Dec.) the rainfall has increased and the crop does not suffer.

No additional fertilizer is applied for the soybeans but they benefit from the phosphorus already applied (See B.2.2.b. Maize above). Nitrogen fixation by this leguminous crop is probably not great on the heavy soils of the area but may have some value to the following crop which is usually rice.

Weeds are controlled by hand weeding. Several insects attack soybeans causing significant yield reduction if not controlled. Progressive farmers use enough chemicals to minimize damage but they are not in majority. This is one of the main factors limiting the crop yield.

The crop is harvested shortly after the maize by cutting or pulling whole plants. They are then either dried and threshed in the field or transported to farm buildings for storage until weather permits threshing With the latter, the rainy season has commenced and yield and quality losses are experienced.

Demand for soybeans is good and there is a ready market. Products of soybeans provide the main source of protein for rural dwellers.

B.2.2.d. Sorghum

A very small amount of sorghum is presently grown in the Lusi area.

The crop has greater yield potential than maize and can be ratooned but with current varieties; its popularity as a food is low. New pura line white-seeded varieties developed at ICRASAT in India would fill these requirements but no effort is being made in this direction.

B.2.2.e. Tobacco

Tobacco is a relatively new crop to the Lusi River area but is already the third most popular dry season crop. This has been in response to the improved price and income potential. With full irrigation, the area of tobacco where rice could be grown would decrease in spite of the income incentive because it would then need to be grown by the surjan method.

B.2.2.f. Cassava and Sweet Potatoes

Cassava in this area is grown mostly on upland ridges (dry fields) where the soils are lighter. Sweet potatoes are grown following rice but the area is small with the lighter soils preferred for this crop also. The average yields in the area in the year 1979 were 4.2 t/ha of cassava, and 8.2 t/ha of sweet potatoes.

B.2.2.g. Miscellaneous Crops

Most of these crops (listed in Part I of this Appendix, on page B-14) will disappear when irrigation becomes available but will be grown in home lands and out-lying areas.

B.2.3. Present Land Use

There are 4 or 5 small irrigated schemes in the Lusi area that have run-of-river wet season water deliveries. One or two of these have some distribution systems but most have only main or central ditches where the added water is spread from paddy to paddy. Since none of this is classified as technical irrigation it is not shown in Table B-1 as irrigated area at present. The cropping intensity is 2.63. This high intensity is realized from growing 2 maize crops on much of the area after the rice crop of the wet season, in the dry season and the labuhan season. This was previously discussed in para B.2.2.b. above. The key farmers and some of the progressive farmers are beginning to grow 2 rainfed rice crops in the wet season as a result of the Extension and BIMAS programs advocating early maturing HYV (primarily IR 36). This total area is small and is presently estimated to be about 1 percent of the total rice area.

The cropping intensity for the present situation in Table B-1 was derived from the SMEC study on the adjacent South Grobogan area, information from the Extension office in Purwodadi and field observations on visits to the study area.

All of the area is in rice in the wet season except the small area devoted to surjan. At present there is no known dry season rice grown in the area. The surjan system is practiced near Purwodadi and other towns or villages of size. Tobacco is grown on a limited area on rice land in the dry season and not on the beds of surjan system. Cassava appears to be the popular main crop on surjan beds with vegetables interplanted. Soybeans are quite popular in the area grown as an intercrop with maize in the labuhan season.

The potential irrigable area was mapped from on-site examinations for lowland rice areas and using a land use map. Contour maps were used to determine command areas (within this potential area) from assumed weir and pumping positions on the Lusi River. The net irrigable area shown in Table B-1 is a total of the three positions: Middle Lusi-Right Bank, Lower Lusi-Right Bank, and Middle Lusi-Left Bank. How this was determined is given in para B.2.1.a.

B.2.4. Present Cropping Pattern/Calendar

The present cropping pattern is shown in Table B-1. As the area is almost entirely rainfed, the present cropping patterns are dependent on the yearly rainfall pattern. SMEC reported a cropping intensity on lowland rice areas in South Grobogan as 2.8 and in what they classified as dry fields 2.26. They determined that 80 percent of that area was lowland and 20 percent dryland. This would give them an overall intensity of 2.69. This intensity is almost identical to one derived from figures supplied by the Extension office in Purwodadi.

The high cropping intensity comes from 2 crops of maize following rice on 90 percent of the land. Soybeans are interplanted in the second maize crop of the labuhan season. The soybean area is shown as part of the maize area and not separately since they are intercropped. Cassava is interplanted with vegetables and sweet potatoes so only its area is used in calculating cropping intensities. The miscellaneous crops (groundnuts, sorghum, green beans and others) are grown on such small areas they were not included in the cropping pattern.

For the rice crop, land preparation and puddling commences in November, but the bulk of it is carried out in December. The onset of the rains determines this and can be quite variable. Late planted labuhan can also occupy the fields late and affect the time the rice can be planted. Transplanting is mostly finished by February but some may continue up to March. One estimate was given that 72 percent of the area now has HYV crop. Other reports show less, so 50 percent is used in this report but recognizing that IR36 is showing rapid acceptance by the growers. HYV crops occupy the land only 3 to 3½ months. The rest of the area grows local varieties (LV) that have a 4 to 4½ month growth period. With the difference in planting times and maturity periods, harvest is now spread out over a long period (January to May). When local varieties were predominant, harvesting was done in April and May.

After rice harvest, fields are allowed to dry out some as small drains are made in the fields. This period may take a month or less and then rough land preparation is carried out for the planting of the dry season maize crop which is planted on about 90 percent of the area. Palawija crops such as tobacco, sorghum and sweet potatoes are grown on the remainder of the land. The short season local maize varieties are ready to harvest in 2½ months. The palawija crops have a longer occupancy period of about 4 months. Dry season crops are grown almost entirely on residual moisture.

Labuhan crops are planted during September and October as rainfall starts to increase at the end of the dry season. Cropping in this season also occupies about 90 percent of the land. Here the maize is intercropped with soybeans. The delay of rains can result in late plantings of one month or more.

Cassava is planted mostly on what is called dry fields. This land is lighter textured and usually along the river. It can also be planted in heavier soils by the surjan method as described in Part I of this Appendix (para B.1.2.) and along banks, levees or edges of the fields. It is planted early in the wet season and is allowed to grow 6 to 10 months, the roots being harvested as required or for marketing. This crop is more concentrated around settlements or villages.

The present areas and average yields of the main crops of the Middle and Lower Lusi valley portions of the project are given in Table B-1.

B.2.5. Present Status of the Irrigation - Drainage Systems

As stated in para B.2.3. above, none of the small amount of irrigation of the area is technical irrigation. No drainage systems exist in the area. Some small local drains have been made to the numerous streams that cross the areas in natural falls from both sides of the river.

There are eight local run-of-river wet season irrigation systems in the area which serve about 2,000 ha of area. Structures and facilities are limited and none of them are technical irrigation.

B.2.6. Development Potential

B.2.6.a. Cropping Pattern

i) General

The comments in Part I of this Appendix are generally applicable :o the Lusi Valley. The following paragraphs in this section contain ıdditional information for the three irrigation areas identified in :he Lusi Valley.

The predicted cropping pattern for the future with project features affording perennial irrigation. It was adapted from the previous study reported in Part I of this Appendix with a few mino adjustments for the Lusi area. Farmers in other areas have shown their performance already that when they can get irrigation water (and not always full requirements), they will grow three crops of rice if at all possible. There has not been opportunity for this actually demonstrated by farmers in the Lusi Valley so far but the is no reason to believe they would be any different than the Indon sian farmers in adjacent and nearby areas. More detailed study at the feasibility level may show that the predicted cropping pattern may be somewhat different for the Lusi Valley as compared to Tunta Jragung but for the purpose of this report it will be assumed that it would be nearly the same.

The cropping intensity in the Lusi Valley is already high at 2.61 (See para B.2.3. above) so the predicted increase to 2.89 in the future with the project is not great. The significant change will be in the shift to rice cropping from the present 2 crops of maize (in one year) grown after one rice crop. An even more dramatic change will be from all rainfed agriculture to fully irrigated and will result in rice being the predominant crop, yields being increased, and the requirement for significant changes in farming practices and farm-management.

(ii) Predicted Land Use

The predicted land use for the future is shown in Table B-1. This is the same as for Tuntang-Jragung except that less surjan is practiced in the Lusi Valley now and the projected amount would be 2 percent of the land instead of 5 percent for Tuntang-Jragung. The difference was added to the predicted 2 rice plus palawija cropping system since following rice crops with palawija is now the common practice in the area.

There is expected to be some problem in completely commanding the rice areas. The many small meandering streams on both sides of the middle portion of the river make some areas difficult to reach with irrigation. They would benefit from water from irrigated portions by paddy to paddy water movement, however. It would take a more detailed study to determine the extent of these areas and the level of irrigation to be expected. The small ridges of the area would create some minor water distribution problems also.

(iii) Future Cropping Patterns

Where farmers in nearby and adjacent areas have irrigation water, they have started growing 3 crops of rice. The practice spreads rapidly in an irrigated area. Assistance programs (Extension and BIMAS) are important initially but farmer to farmer contact is the major factor in complete spread of the practice. The future cropping pattern is based on the reliability of irrigation water almost year-round, the availability of inputs and other factors discussed in detail in Part I. When attempting 3 crops, farmers show that they rapidly accept the IR 36 as a needed HYV crop under irrigation. It is doubtful that they all know of its value as a brown plant hopper resistant variety but researchers and extension appreciate this valuable characteristic. Not all farmers initially accept the need for increased inputs (fertilizer, insecticides) and/or the levels needed. It is assumed that in 5 to 7 years after project irrigation is made available that most of them would be using near optimum levels of inputs.

The predicted cropping pattern for the total of the three portions of the Lusi Valley is given in Table B-2 (Future with project). It is anticipated that on 360 ha or about 3 percent of the total area, farmers will still grow the glutinous local varieties used for confections and ceremonious occasions. Even these could be replaced by glutinous HYV if extension should include this in their program.

The main features of the cropping pattern are discussed in Part I of this Appendix, on page B-46. Additional comments are given below.

(iv) <u>Land Preparation</u>

A study on mechanization would be useful. It is possible that farmers growing 3 crops of rice per year could afford to band together and purchase small hand tractors. A study should show how much area would be needed to support a tractor. Since the farm size is small, it might involve too many individuals to be workable. The needed cooperation between even a few individuals can sometimes be difficult. Even though labor is plentiful, a speed-up in land preparation would be desirable in a 3-rice crop system.

Land preparation will be more thorough with irrigation water available and more draught animals can be used. Pre-plant irrigation water will enable timely planting and a good start for the crop.

(v) Constraints to Future Cropping Pattern

The development of a 3-crop rice system over a large area in a relatively short time will not be without its problems and difficulties. Many of these will be solved as they are encountered. Possible constraints are listed and discussed in Part I of this Appendix, on page B-47 and further comment is given below.

1. Human Factor. Reluctance to give up old ways and conservative approaches to inputs will cause some farmers to be slow to adopt new practices even though neighbors are demonstrating successes. This has been observed in present intensive areas nearby and other areas of Asia.

2. Land Preparation. (See subpara B.2.6.a. (iv) above)

3. Manual Labor. Even though labor is relatively plentiful, ways should be sought to reduce hours needed in order to meet the heavier demand of the intensified rice culture. An example is the cutting of individual heads at harvest in the field (ani-ani). Cutting the whole plant and getting it off the field soon is desirable in having a short turn-around period between crops. Heads could be separated for drying away from the field. The rice can also be threshed by hand in the field as is done in many countries in Asia, or with little added investment, more rapidly harvested in the field with pedal threshers.

4. Varietal Preference. (See subpara B.2.6.a.(iii) above.)

5. Seed Supplies - Seed should not limit the area of HYV grown but the quality of the seed will need attention in a rapidly expanding area. In present 3-rice crop areas, the problem of local

variety mixtures in HYV fields in minimal. Genetic purity may be another thing but there was not sufficient time to properly make an assessment of this. It did not appear to be a problem however. Seed is spread from farmer to farmer and tall off types are separated out at harvest. A few fields from careless seed selection were observed and hopefully this will not be passed on as seed. Sub-District Extension offices have the authority to grow certified seed called "Extension Seed" on their farms to distribute to key growers. Key growers grow the seed crop under the supervision of the Sub-District Extension office and their seed is distributed to progressive growers who then grow seed for themselves and neighbors. Not all Sub-District Extension offices have a farm for producing their seed now but it is a national plan to provide this. These farms will be 10-15 ha each. The Extension office obtains their seed from Bogor or Sukumandi (National Seed Form) where it has been produced under the supervision of researchers.

6. Inadequate Water Management. The importance of good water management was stressed in Part I of this Appendix and will also be discussed in Section B-10 of this part.

(vi) Delay in the Adoption of Cropping Patterns

See statements in Part I of this Appendix, on page B-49. The development of the complete water distribution system and experience in delivering water is expected to cause the greatest delay in the adoption of new cropping patterns in the Lusi Valley. Year-round irrigation will be new to almost the entire area.

B.2.7. Yield Projections

Yields are projected for the future without the project and the future with the project situations. These appear in Table B-1.

Without project yields are expected to only moderately increase but with the extension program there would be a significant shift to 2 crops of rice even-though still rainfed.

Future yields with the project were based on the same assumptions stated in Part I of this Appendix on page B-50 and are less than those projected for the Tuntang-Jragung area because the Lusi Valley area has no previous experience with irrigation. The future with the project yields shown in Table B-1 are projected average yields for the entire area. It is realized that with reliable irrigation water even temporary water shortages in the wet season would be eliminated plus allowing dry season crops to be grown without risk. With this reduced risk situation, farmers will have more confidence in using higher rates of fertilizer and adequate pest control programs. Some growers may exceed 6 t/ha with present HYV or improved ones of the future but considering possible constraints mentioned above, the average expected yields for the entire area were assumed to be 4.3 t/ha for the 3-crop system and 4.5 t/ha for the 2-crop system.

B.2.8. Irrigated Areas

A total area of 13,825 ha is available for irrigation with none of this now receiving technical irrigation. A few local small areas have run-of-river wet season supplemental irrigation only. With proposed storage facilities (Appendix C, Part II) and an adequate distribution system, the Lusi River can provide sufficient water to fully irrigate the area. The potential service areas for the Lusi Valley are as follows:

	ha
Middle Lusi, left bank	4,200
Middle Lusi, right bank	4,000
Lower Lusi, right bank	5,625
Total	13,825

The possible benefits from run-of-river wet season irrigation without storage were also taken into consideration. The expected cropping pattern in this situation is given in Table B-1 as Future with (R-R) as compared to Future with (P) - perennial or full season irrigation. Crop Water Requirements (CWR) and irrigation demands are given in paragraph B.7 below.

B.3. JUANA VALLEY

The total area referred to in this study is called "Serang Project Study area plus Juana Southeast". It is roughly a 15-km wide area south of the road and between Kudus and Pati, all in the Juana Valley. The study area totals 30,000 ha of irrigable land. It includes five areas now under study by Snowy Mountains Engineering Corporation of Australia (SMEC), an other consultant working in the Jratunseluna Basin [3]. These are generally east of the Wilalung structure plus a 2 to 3 km wide area just west of the Kajen-Pati road and running from 3 km west of Kajen to 9 km north. The SMEC study areas are given below:

	ha
Undaan	4,500
Prawoto	4,000
Sukolilo	2,500
Sana	2,500
Dermoyo	500
Total	14,000

In addition to the above areas, two other areas are included in this study. These were determined by on-site reconnaissance and use of contour maps. One of these areas covers all the present swamps and although portions are not swamps or even flood-prone, it will be designated "the swamp area". This area essentially involves those areas not included by SMEC, south of the 9,200 ha area and located both sides of the mid-section of Juana River just west of Pati. This area is estimated to have 6,000 ha of irrigable land. Very little village space is found here.

The other area is designated "Southeast Juana" and lies southeast of the Kajen-Pati road as shown on the map (Figure B-1). It has a gross area of about 14,000 ha and a net irrigable area of about 10,000 ha. This area extends 6-10 km east of the road beginning 3 km south of Pati, surrounding Gabus, and narrows down in distance from the road beginning at Tambakromo continuing southwesterly to include an area south of Kajen.

The total areas then of the "Serang project study area plus Juana Southeast" are as shown below.

	Gross ha	Irrigable ha	
SMEC study	16,000	14,000	
Swamp area	6,000	6,000	
S.E. Juana	14,000	10,000	
Total	36,000	30,000	(83%)

A portion of this part of the valley is adjecent to some of the above but was not included. It is the area from Kudus to Pati extending about 5 km on the south side of the road (except for 4-km wide section of this which is 6 km west of Pati, See Map, Figure B-1). The "5-km south of the road" area is where partial irrigation from small dams is found. These dams retain water from the slopes of the Muria volcano and according to SMEC [3] about 5,400 ha arable land is irrigated out of a total of 9,200 ha. This area cannot easily be commanded from the Wilalung structure.

There are gently sloping areas producing crops south of Prawoto and Sukolilo. On the other side of the valley, some of the areas south of the Kudus-Pati road slope towards the valley from the north side. The area of this study however, all lies in a fairly low position in the flat alluvial plain of the Juana River.

B.3.1. Soils

A semi-detailed soil survey of the Juana Valley was planned but was not able to be carried out. Comments on the soils are obtained from maps and descriptions given by the extension offices in Kudus and Pati. The soils in the valley are mostly heavy clays although the valley is "rimmed" by low terraces of lighter soil (a light reddish brown soil with high silt content). The soils presently under swamp and those just above them are expected to show good crop fertility levels when drained. They have been receiving sediment deposits from the Serang River overflow through the Wilalung structure for many decades. The soils on both sides of the river are yellow brown to grey humic clays. The surrounding soils are yellow brown to grey margalitic clays with high clay content. All are good rice soils high in calcium and magnesium, moderately supplied with pottasium but low in phosphorus. The pH values were not known but should be slightly alkaline (7.2 - 7.5).

B.3.1.a. Land Classification

Information on land classification was obtained from maps published by the Department of Internal Affairs, Agrarian Directorate, the SMEC Inception Report and the Extension offices.

Except for area in swamps the entire study area is classified as rice land. Non-productive areas (villages, homeyards, cemetaries, etc.) are found more in the Kajen-Gabus section. The estimated 10,000 ha net irrigable area is from a gross area of 14,000 ha. In the southeast Juana Valley, then, the net irrigable area is 71 percent of the gross. Land flooded varies from year to year and is reported to be from 7,000-12,000 ha. Most of this is cropped but due to lateness of planting, will have only one-rice crop per season. The swamps will of course have no crops. The area they cover may vary some and is estimated to be about 6,000 ha. The center of the valley without drainage is almost inhabitable.

Deep percolation losses would be high on the soil around the edges of the study area but the majority of the soils in the valley are heavy or silty clays. A loss of 1.25 mm/day is used as an average for the whole area.

B.3.1.b. Salinity

No known problem with salinity exists in the area or would one be expected in the swamp when they are drained.

B.3.2. Crops Grown and Cropping Methods

Part I contains detailed information on crops and is applicable to the area. Comments on the crops that are specific to the Juana Valley is given in the following paragraphs.

B.3.2.a. Rice

The rice production is quite variable in the Juana Valley. Where farmers get year-round irrigation (Undaan System), they are growing three-rice crops a year. Two rice crops a year without irrigation is catching on east of Gabus, south of Pati and in smaller areas. This is primarily the result of extension activities. One crop a year is still found in most of the area due to flooding conditions or the perennial potential for flooding. Some plant early and hope their rice come through deep water but others who get from 0.5 to 1.5 m depth of flood water must wait until the water recedes to plant. HYV crops are being accepted rapidly in the first two situations but local varieties are still the majority used in the latter. The HYV used in the area is almost all IR 36.

Fertilizer use is universal where HYV are grown but rates were noted to be generally less than optimum except in the Undaan irrigated area. Low rates are used on LV.

The present overall yield for 1979 in the area was reported to be 3.6 t/ha for HYV and 2.7 t/ha for LV in lowland. The yield for LV in dryfields was 1.7 t/ha. Considering the flood damage, the LV yield was taken as 2.0 t/ha.

An outbreak of bacterial leaf streak was found about one-half distance between Pati and Kajen. It was not extensive and developed late in the crop's ripening period so damage may not be serious. The danger in a one-variety approach comes to mind and extension and researchers should be forewarned.

B.3.2.b. Maize

Maize is not an important crop in the Juana Valley but yields reported are good. It is not grown in the 2 crops after rice system as in the Lusi Valley but as a single crop after rice with some soybean interplanting and as the main crop following flooding, with or without soybean interplanting.

Maize as a crop is discussed in more detailed in Part I of this Appendix, on page B-11 and under the Lusi Valley section of this report.

B.3.2.c. Soybeans

Soybeans are planted on 55 percent of the area planted to maize and are also not a popular crop in the area. The poor drainage situation on much of the valley is not conducive to soybean production and yields are low.

B.3.2.d. Sorghum

Sorghum is gaining in popularity in the area south of Kudus. This is the Undaan system area that was previously irrigated and is now subject to flooding. Sorghum is planted here after the late planted rice crop (delayed by flooding) because of its drought tolerance. Average yields of 1.3 t/ha are reported. The sorghum area does not show in the cropping pattern since its area is insignificant when considering the entire development plan area as a whole. The crop is not expected to be grown when adequate irrigation water becames available and a 3-rice crop growing system takes over.

B.3.2.e. Tobacco

There was no report of tobacco being grown in the area.

B.3.2.f. Cassava and Sweet Potatoes

Cassava is a popular crop in the Juana Valley, more on the lighter soils on the outer edges than in the lower valley areas. Good yields of 9 to 11 t/ha are reported. The total area reported by the Extension offices in Kudus and Pati for cassava was 13,060 ha and 540 ha, for sweet potatoes.

Much of the cassava is outside the study area. An area of 2,160 ha was estimated to be in the area of the study. This area is expected to decline when irrigation becomes available but the crop will still be grown on 5 percent of the irrigable area.

B.3.2.g. Sugar Cane

There is sizeable area of sugar cane grown in the Tambakromo-Kagen region at present. It is grown as a rainfed crop. Yields given in the field were considered high. These reported as 70-100 t/ha appeared to be actually 50-75 percent of the reported figures. Recovery is stated at 9 percent which is average in the tropics. The crop would show benefits from irrigation and the harvest season would be lengthened.

Synchronization of planting and harvest could be practiced with sugar cane under irrigation. This would result in a longer processing period thus increasing the output of the sugar production plant. How much this is needed or desired would be a factor in determining irrigation benefits to sugar cane. An increase in the total output of the factory would be realized as a result of the lengthened processing period and the value of this should be considered.

The benefits of irrigation to the sugar cane crop needs to be investigated and studied. The benefits may or may not be great enough for farmers to continue growing the crop under irrigation compared to the 3-rice crop system. This should be studied in detail .

B.3.2.h. Hemp (Rosela)

A hemp crop with the local name "Rosela" is grown between Tambakromo and Kajen. It is used for making "rough type" baskets for carrying or storing produce and other items. It is doubtful that irrigation would benefit this crop and it would give way to multiple rice cropping.

B.3.2.i. Miscellaneous Crops

Most of those crops listed in Part I of this Appendix on page B-14 are grown in the study area but on small hectarage. They will be replaced when irrigation becomes available and will be grown in home lands, in villages, or outlying area.

B.3.3. Present Land Use

No crop is grown on the area that is presently swamp. It is estimated to be 6,000 ha and can change some in size according to the yearly rainfall variations. Very little area is taken up by villages and other non-crop uses in the valley because of the flooding and drainage problem. The eastern one-third of the study area is heavily populated and 30 percent of the land is used for villages, homeyards cemeteries, etc. All of the study area is suitable for rice and would benefit from irrigation if sufficient water is available. The majority of the area can be commanded by gravity water but some areas would need sequential low-lift pump systems.

An area of about 2,100 ha receives wet season irrigation in the study area for the existing systems out of which 1,100 ha get some dry season water. The status of the existing systems is discussed in the next portion of this report (B.4.).

Out of the gross area the net irrigable area is 30,000 ha (83 percent) of 36,000 ha. This may be optimistic. With the project, flood water from the Serang would be stopped, drainage provided and the swamp area made productive. Villages and other non-farm uses will probably increase in the valley and the net irrigable area will subsequently be reduced somewhat over a period of time.

The gross areas and net irrigable areas are given in the preceding para B.3.

B.3.4. Present Cropping Pattern/Calendar

The present cropping pattern is shown in Table B-2. The present cropping pattern is derived from crop figures furnished by the Kudus and Pati extension offices and information provided by them on rice cropping intensities. The present cropping is influenced by the amount of flooding, amount of irrigation, and the rainfall pattern. The present cropping intensity is low at 1.63 because of the flooding and drainage problems. Only one crop of rice is grown on 61 percent of the area. One-half of this has some palawija crop following the rice. Two-rice-crop pattern under rainfed conditions is on the increase especially near Gabus but also in other areas. At present, three-rice crops are grown on 9 percent of the project's present irrigable area where irrigation water is available.

Rice covers 89 percent of the area during the wet season. Nine percent of the area is listed as cassava. Other crops are grown with cassava but the land is not occupied by rice anytime during the season. In areas where rice cannot be planted because of flooding and/or late rains, maize is grown as a catch crop and is sometimes interplanted with soybeans.

Maize and soybeans are not as popular in the Juana Valley as in the Lusi. By present standards, they do get good yields, however. These crops are planted as the second crop only on 49 percent of the one-rice crop area.

The present yields are given in Table B-2.

B.4. PRESENT STATUS OF THE IRRIGATION - DRAINAGE SYSTEM

There are four systems that now provide some irrigation water in the area of the study. They are described below:

B.4.1. Undaan Irrigation System

The Undaan area is just north of the Wilalung structure. In 1916, about 3,700 ha of land was irrigated from the intake gates at this structure. Due to the diversion of the Serang River floods into the Juana Valley, the bed of the river gradually rose and flooding became of a regular occurence. Canals silted up, structures deteriorated, and the irrigation scheme gradually became inoperable. At present, only 800 ha of area located in upper part of the system receives irrigation water during the wet season. One-half of the area gets some dry season irrigation water and 3-crops of rice are grown over almost 100 percent of the 800 ha. It is the most intensive rice production area in all the valley.

B.4.2. Kapur Utara Hills

Schemes supplied by streams emanating from the Kapur Utara hills are mainly located south of Pati. They are classified as semi-technical. Water shortages occur during the dry season. The catchments are small, the largest being only 20 km^2. No small storages exist in these hills and the prospect for such developments do not look promising. Characteristics of these streams is an excess of water in the wet season while dry season flows are very low and already fully committed. These schemes will not be considered a source of irrigation water supply in with-the-project situation.

B.4.3. Spring Field System

Springs discharging from the lime stone of the Kapur Utara hills supply irrigation water to about 300 ha. They are classified as non-technical since no permanent structures exist in the area. Rice is grown in the wet season but there is not enough water for rice in the dry season. Whatever amount of water is available in the dry season, is used for growing palawija crops.

B.4.4. Pumped Supply Systems

Several pumping stations are in operation in the project area irrigating about 250 ha. Some of the stations draw water from the Juana River and others pump from streams emanating from the Muria Volcano slopes. One pumping station located near Prawoto, pumps its water from Rawa Ngoban and irrigates about 35 ha. Most pumping stations are privately owned and the water is supplied in exchange for a share of the harvest, usually one-seventh of the produce.

The four systems and the area irrigated are given below.

Irrigation System	Area (ha) Wet Season	Dry Season
1. Undaan	800	400
2. Streams from Kapur Utara	750	250
3. Springs Field	300	300*
4. Pumped Supply	250	150
	2,100	1,100

* Palawija Crops.

B.5. DEVELOPMENT POTENTIAL

B.5.1. Cropping Pattern

B.5.1.a. General

The comments in Part I of this Appendix and those for the Lusi Valley are generally applicable to the Juana Valley - "Serang Project Study area plus Juana southeast". The following paragraphs in this section contain additional information specific to the Juana Valley.

The predicted cropping pattern assumes the following:

1. That flood waters would no longer be diverted into the valley at the Wilalung structure,
2. The drainage works would be sufficient to make the swamp area arable and provide adequate drainage for all other problem areas, and
3. The entire study area would feature affording perennial irrigation (as discussed in Para B.3.3. above). With these assumptions, the predicted cropping pattern used for Tuntang-Jragung was used for Juana Valley with the substitution of cassava for surjan which is not practiced to any extent in the Juana Valley.

Farmers in the Undaan system are already engaged in growing 3 crops of rice over almost all of a 800-ha irrigated area. They are also doing this on 5,400 ha irrigated from the streams systems below the slopes of the Muria Volcano. There is ample local experience then to be transferred to other parts of the valley when irrigation does become available. The practice of growing of 2 crops under rainfed conditions is also spreading and this experience is transferrable to multiple rice cropping with irrigation.

B.5.1.b. Predicted Land Use

The significant changes in land use will be the reclaiming of the swamp areas and providing drainage for other problem areas. This will add 6,000 ha of land available for production and make other areas much more productive than at present where poor or no drainage is provided. New villages may be established in the valley and some land taken up for other purposes when people are able to live in the area but, the overall benefit will be large.

With completion of the project, the three small irrigation systems in Sections B.4.2. thru B.4.4. would not be needed. They now irrigate 1,100 ha. With perennial water reaching all the area of the project either by gravity or sequential pumping system, an area of 30,000 ha will be fully irrigated. The predominant crop will be rice.

B.5.1.c. Future Cropping Patterns

The predicted cropping pattern is given in Table B-2 under "Future With". The more detailed comments in Part I of this Appendix on page B-4 and the Lusi Valley discussion under this para would pertain to the Juana Valley and are not repeated here. The growing of 2 or 3 crops per season of rice would spread rapidly over most of the area when irrigation water becomes available. The spread would take more time in the present one-rice crop areas where flooding and/or drainage is a problem and in the present swamp areas after reclamation. Fields will need proper shaping and levelling, bunds formed or re-shaped, and the land cultivated for cropping. This lag in time over land already in rice production (and free of the above problem) is estimated to be 2-3 years.

The predicted cropping pattern for the total 30,000 ha in the "Serang Project Study Area Plus Juana Southeast" in Table B-2 shows 71 percent of the total area in 3 crops of rice or 63,900 crop ha. Fourteen percent of the area will be in 2½ crops for a total of 10,500 crop ha and 10 percent of the area will be in 2 crops of rice followed by a palawija crop (maize with two-thirds of its area interplanted with soybeans). About 300 ha (1 percent of the total area) would continue to grow local varieties of the glutinous type crops. The total rice crop area per season with the project will be 80,100 ha with an annual production of over 347,000 tons of rice. Cassava is presently a popular crop in the area but surjan is not practiced to any extent. Cassava appears in the cropping pattern then in place of the surjan found in all other patterns (Tuntang-Jragung, Dolok, Penggaron, and Lusi Valley). There are several minor crops that are interplanted in cassava but it would be difficult to show them in the cropping patterns. Cassava, therefore, represents several crops in the pattern.

B.5.1.d. Constraints to Future Cropping Pattern

The constraints to the future cropping pattern discussed in Part I of this Appendix and in other portions of this Part II, mostly apply to the Juana Valley but constraints peculiar to this area deserve comment.

(i) Labor Availability

Moving into an area with new production where the population is sparse would normally mean there would the risk of an inadequate labor supply. There will be adequate labor available nearby because of the proximity of two cities; namely, Kudus and Pati but the problem may be the transport or movement of labor in order to meet the demand where and when it arises. Should families move into the center of valley rapidly, this would not be a problem.

(ii) Land Preparation

Draft animals are likely to be in short supply in the newly drained and reclaimed areas. It will take a few years for them to move in since they will accompany the movement of people into the area. Draft animals cannot be moved long distances into the area and back out on a hired basis but need to be indigenous to the area.

(iii) Access to the Area

The non-existance of adequate roads, and the poor state of maintenance of those existing are a problem in all of the rural area of Indonesia. In the middle of Juana Valley, there are almost no roads at present. Roads are not part of the planned project works and their usual pattern of development may be slow even after the irrigation works are completed. Transport of inputs into the area and rice out of the area will be under difficult circumstances unless something is done to build new roads for the central portion of Juana Valley (See also following).

B.5.1.e. Delay in the Adoption of Cropping Patterns

See statements in Part I of this Appendix on page B-49. Working out the management and delivery of water in newly irrigated area will take time in the beginning. The valley is surrounded by areas that do get irrigation water into the dry season now and 3 crops of rice is grown on these areas. When water can be delivered, the farmers readily move into the 3-rice crop system. Any delays encountered will be caused more by inadequate water delivery rather than slow adoption of new cropping methods by farmers.

B.5.2. Yield Projection

Yields have been projected for the future without the project and the future with project situations. These appear in Table B-3.

Without-the-project, yield would increase moderately with some increase in inputs (fertilizers and pest control) in growing of HYV crops. This would in part be a result of the extension, BIMAS and INMAS programs.

The area where two rice crops are grown under rainfed conditions will nearly double in the future without the project but will be limited to 36 percent of the total area because of poor drainage and flood problem areas.

"With the project yields" are based on the same assumptions as given in Part I of this Appendix, but are somewhat less than those used for Tuntang-Jragung area. The future with-the-project yields are shown in Table B-2. Most of the area will be new to irrigation methods and practices and the reclaimed swamp area will be new to cropping. Although some farmers will get very good yields of up to 6 to 7 t/ha there are always those who use lower rates of fertilizer and little or no pest control for financial, lack of credit, and various other reasons. Considering this and other possible constraints listed above in para B.5.1.d., the predicted average yields are 4.3 t/ha for the 3-crop system and 4.5 t/ha for the 2-crop systems.

B.5.3. Irrigated Areas

A total of 30,000 ha of area is available for irrigation with the project. The present cropped area is 24,000 ha. Reclamation of 6,000 ha of swamp would provide the difference. The present fully irrigated area is 800 ha. Partially irrigated areas total 1,100 ha.

B.6. DOLOK-PENGGARON SERVICE AREA

The service area is situated in the Jratunseluna Basin which is the catchment area of five rivers in the northern part of the Province of Central Java. The whole of the basin is east of the city of Semarang and the Penggaron and Dolok service area is adjacent to Semarang. The area was included in NEDECO's study [1] of 1971 which was 4,590 ha for Penggaron and 2,735 ha for Dolok. For the purposes of this study, only the southern portion of Dolok measuring 1,958 ha is included. The total of the two service areas now is 6,548 ha. The areas are shown on the map, (Figure B-1).

The remainder of the Dolok area (777 ha) is now a part of the Jragung service area study.

In the south, the boundary is determined by the level of the existing diversion dams on the Penggaron River (Pucanggading) and on the Dolok River (Barang). The western boundary is the Banjir Canal and the northern boundary runs generally along the Demak road. The area north of this to the sea coast is not included in this service area even though it is a part of the same plain. This area will get water from the Prauwvaart canal. The canal is fed by tail water from the Jragung-Tuntang area. The eastern side is bounded by the Tuntang-Jragung areas (Part I of this Appendix).

Flooding is a problem to the cropping of the areas in January and February with 10 percent of the Dolok and 20 percent of the Penggaron affected. The lower one-third of the latter was flooded in late January, 1980.

Factories and housing expansion as part of the city of Semarang are encroaching on the west side of Penggaron but the extent of this has not been determined at this time. Taking this into account, it is estimated that the gross area of Penggaron-Dolok is approximately 11,500 ha with the 6,548 ha being the net irrigable area.

B.6.1. Soils

There are two soil types in the Dolok-Penggaron service area. About 70 percent of the area in the south is covered by a young soil. It is a grey or brownish grey margalitic soil and is lighter than those in the lower plains of the basin but still has 50-65 percent clay content and has slow infiltration and low deep percolation rates. This soil is near neutral in reaction and has good potassium, calcium and magnesium levels but is relatively low in phosphorus.

The remaining 30 percent of the area has a heavier soil and lies on the northern edge of the area next to the Semarang-Demak road in a lower plain. It is a margalitic heavy clay with black to dark grey color. The top soil has a pronounced crumbly structure when dry and shows deep cracks but is sticky and plastic when wet. This soil is rich in potassium, magnesium and calcium but low in phosphate. The pH is above neutral in the 7.5-8.0 range.

Minor element problems are not expected on either of these soils.

B.6.1.a. Land Classification

No specific land classification information was available on the area but from the NEDECO report [1] and land classification maps, general statements can be made. The area is all classified as suitable for rice and therefore all suitable for irrigation. The heavier soils fit this category well as class 2 rice soils but the 70 percent of the area with lighter soils would be Class 3 for rice and Class 2 for diversified crops. This is exhibited by the popularity and spread of the surjan method of growing crops.

Approximately 1,100 ha or 17 percent of the total area is affected by floods on a fairly regular basis. Flood control relief measures are not planned at this time but dams on the two rivers would provide some relief.

As mentioned above, the town of Semarang is presently encroaching on the Penggaron area. There is also more space used already by villages because of the proximity to Semarang. Homeyard and garden crops do come from these village areas, however. The net irrigable area then is only about 57 percent of the gross area of approximately 11,450 ha.

Deep percolation losses for this area are discussed in para B.7.4 below.

B.6.1.b. Salinity

No known salinity problem exists in this service area but these problems are encountered just north of the area across the Prauwvaart canal. (See Part I of this Appendix).

B.6.2. Crops Grown and Cropping Methods

Detailed comments have been made in Part I of this Appendix and it is not necessary to repeat them here. The following comments apply to the Dolok-Penggaron in particular. See Table B-3 for areas of crops grown and yields.

B.6.2.a. Rice

Almost all of the Dolok-Penggaron service area not in surjan cropping is in a one-rice crop culture. The elevated and lighter soils do not have enough rainfall to finish a second crop plus these soils are adaptable to other crops. Sixty percent of the lowlands are subject to flooding so they must wait until the threat of floods have diminished before they can plant and therefore get only one rice crop. There has not been as much emphasis in this area then on HYV and growing 2 crops of rainfed rice as there has been in other areas of the Jratunseluna Basin.

One 400 ha area where some irrigation water has been made available now produces 3 crops of rice. Here the farmers are showing that they will use increased inputs and grow HYV crops when water is available. Other farmers will exhibit the same ability if irrigation water is available but the whole service area is presently behind other parts of the Basin in adapting new rice growing techniques. This a result of the above mentioned rice crop difficulties.

B.6.2.b. Maize

Maize is an important crop in the area in the labuhan season because it is well adopted to the lighter soils. Some is grown in the dry season after rice (especially on the heavy soils) but the "two crops of maize after rice" system that is so prevelant in the Lusi valley is not practiced much here. (see "maize" under Lusi Valley for further discussion on this crop).

B.6.2.c. Soybeans

Soybeans are not interplanted in the labuhan season with maize as extensively in this area as in the Lusi Valley. They are grown with maize on the surjan beds, however.

B.6.2.d. Sorghum

Very little sorghum is being grown in the rice growing area at present. This crop in this area would be well suited to home lands and gardens in the villages. It could be ratooned several times where proper care could be given to the crop such as hand watering in dry periods. Instead of food types of sorghum, feed types could be grown and fed to poultry since good market demand and outlets exist in nearby Semarang for meat and eggs. With the introduction of irrigation, sorghum would be a desirable crop for the area in the dry season.

B.6.2.e. Tobacco

Tobacco is now an important income crop even though growing it is relatively new to the area. This crop is the reason for the recent significant increase in the surjan method of farming up to 18 percent of the total area. Irrigation would have little or no benefit to the surjan farming method. So it is expected that area devoted to it would decline with the project.

B.6.2.f. Cassava and Sweet Potatoes

These crops are grown in the surjan beds alone or intercropped. The lighter soils are suitable to them and although with irrigation, rice will be the predominant crop, they should retain a prominant role in the cropping pattern. The growing of these crops may shift to ridges, ditch banks and village areas.

B.6.2.g. Miscellaneous Crops

There are many of these crops grown now because they can be marketed in Semarang. Watermelons as an example are widely grown in the area but could not be grown this extensively in places too distant from a market. Egg plant (terong) is another such crop. Many of these crops will disappear from the areas where they are now grown when irrigation becomes available but due to their popularity, much of the production will be shifted to home lands and out-lying areas.

B.6.3. Present Land Use

There is one area that gets some irrigation water from the Penggaron River and some times grows 3 rice crops. There is not enough run-of-river water for this in all years. The 400 ha area is 3.5 km below the Pucanggading Weir on the left bank.

The net irrigable area was estimated by NEDECO [1]. The surrounding area is not typical of the usual rural setting because there is more space devoted to villages, homeyards and other purposes since it is adjacent to the city of Semarang. The entire area would be irrigable if it were not for this. The gross area was roughly measured to be about 11,450 ha. If urban spread continues unabated in the western one-third of Penggaron, the net irrigable area will shrink in proportion.

The cropping intensity for the present situation was derived from figures furnished by the District Extension Office in Semarang. There is not much evidence in the area that farmers are trying the two-crop system under rainfed conditions as found in other rice areas. This may be due in part to the fact that extension is not a well organized here as in the extensive rice growing sections.

B.6.4. Present Cropping Pattern/Calendar

The present cropping pattern is shown in Table B-3. The area is almost entirely rainfed with some run-of-river wet season irrigation but none in the dry season. The surjan method of growing crops has been rapidly increasing in recent years and now covers 18 percent of the area. This is more extensive than anywhere else in the Basin and has proven profitable because of the increased income from tobacco and vegetables. Except for the small irrigated area, the rest of the land grows only one crop of rice. See para B.6.2.a. above. The cropping intensity is presently 1.59. This is not as high as other areas in the basin primarily because of the limitation of rice to one crop in 76 percent of the area (18 percent surjan and 6 percent irrigated excluded). Unfortunately, Table B-3 does not properly show the number and diversity of vegetable crops grown in this service area. With so many crops, and grown in combinations with others on surjan beds or as palawija crops, it could not all be included in one Table. With three distinct areas involved, the need for uniformity in reporting required one crop to be used in Tables B-1, B-2 and B-3 to represent all the others. In this case, cassava is used. As mentioned in Part I of this Appendix on pages B-19 and B-20, surjan cropping is complex so estimating a cropping intensity is difficult. Therefore, surjan cropping has been considered as 200 percent in assessing its share of the total cropping intensity.

Rice production practices are the same in this area as described in Part I of this Appendix and in the Lusi Valley section of this Part II in para B.2.4. Surjan practices are detailed in Part I, page B-19.

B.6.5. Present Status of the Irrigation-Drainage Systems

The present status of the irrigation and drainage systems is covered in detail in Part I of this Appendix on pages B-41,42. More extensive information can be obtained from NEDECO's "Explanatory Notes on the Rehabilitation of the Penggaron and Dolok areas." - Semarang-Kudus Irrigation Rehabilitation Project, January 1979.

B.6.5.a. Existing Irrigation Systems

The Dolok and Pucanggading (Penggaron) systems lie immediately east of Semarang and therefore the western most portion of the Jratunseluna Basin.

Rehabilitation and new construction are all under the control of the Jratunseluna Project office. This not only includes the regular requirement of Public Works to design and construct the conveyance system down to the tertiary turnout plus 50 m but now includes the implementation of the new Tertiary Program that conveys water to the subtertiary units.

The following sections cover the features of the two areas including the physical features, rehabilitation and tertiary development programs and possible constraints to optimum rice production.

(i) Pucanggading Weir (Penggaron River)

The irrigation situation below this weir is described in detail in Part I of this Appendix, on page B-22. A few additional comments will be given here.

Rehabilitation work has been completed to the Semarang-Demak road on secondary canals and on 370 ha of tertiary canals. Water has not reached the lower ends of the secondary canals. The tertiary work then is done in the higher locations. More discussion on tertiary works follows in para B.6.5.a. (iii).

(ii) Dolok Weir

The irrigation situation below this weir is described in detail in Part I of this Appendix, on page B-23. Additional comments are given below.

Rehabilitation has been completed on secondary canals in the area. Tertiaty work has been completed on about 100 ha. (See para B.6.5.a. (iii) following).

(iii) Tertiary Project

See Part I of this Appendix, on page B-31 for a discussion of this subject that not only covers the Dolok-Penggaron but the tertiary construction program for the Jratunseluna Basin. The Dolok-Penggaron service area is now receiving little attention since the major emphasis is centered in the Tuntang-Jragung service area. One reason given for this is the inadequate water supply to even reach the tails of secondary canals. Another is the lack of any sign of a definite policy for the future in regard to the urban encroachment in the western one-third of the Penggaron area. Eighteen percent of the area is now in surjan and the practice is expanding. A perplexing problem for the irrigation development people is predicting farmer's attitude and willingness to convert to year-round rice production should reliable water become available. Their decisions are needed before tertiary construction should begin. This is yet another reason why the Dolok-Penggaron service area is receiving little or no attention. The total tertiaries now installed cover only approximately 470 ha. The cost of developing tertiary systems in the area has been estimated as Rp. 70,000/ha.

No further comments are offered here for the Dolok-Penggaron but for further information on the irrigation situation, pages B-33 - 42, of Part I this Appendix and the aforementioned NEDECO report, should be consulted.

B.6.6. Development Potential

B.6.6.a. Cropping Pattern

(i) General

The comments in Part I of this Appendix are generally applicable to the Dolok-Penggaron service area. This area does have some characteristics that make it distinctly different from all other areas in the Basin, i.e. soils and urbanization. The following paragraphs in this section contain specific information or discussion for the Dolok-Penggaron service area.

The predicted cropping pattern for the future-with-project features affording perennial irrigation. As noted in previous paragraphs, a decision is needed in predicting the extent of conversion from surjan to 3 rice crops when water is available. The predicted cropping pattern is given in Table B-3 - Future With Project - and assumes that surjan farmers would reduce this area to one-fourth its predicted size of the future-without-project. Rice growing is more familiar to Indonesian farmers and less labor intensive than the surjan farming. Surjan is dependent on rainfall, but with its high value tobacco crop can produce more income per ha than a 3-rice crop pattern so it is a debatable situation as to the decisions farmers will finally make. The picture may be clearer when more extensive studies are made in the future. Two and three-rice crop experience in the area is minimal (400 ha - para B.6.2.a above) but farmers in other areas quickly adapt the practice if water is available. It would be a dramatic change for the Dolok-Penggaron service area however.

(ii) Predicted Land Use

The predicted land use for the future is shown in Table B-3. This is the same as for Tuntang-Jragung area realizing that there may be minor differences in Dolok-Penggaron if the continuance of surjan with tobacco and vegetables and the loss of land to housing and factories are considered.

(iii) Future Cropping Patterns

The discussion in the first paragraph in this section covering the Lusi Valley is applicable to the Dolok-Penggaron service area since experience with multiple rice cropping has also been limited here.

The predicted cropping pattern is given in Table B-3 (Future with project).

(iv) Constraints to Future Cropping Patterns

This is discussed in Part I of this Appendix and additionally in the Lusi Valley portion of this Part. All the points made there apply to the Dolok-Penggaron service area with water management deserving further comment. Poor bund formation, maintenance and water management was observed in the area. This is partially attributable to the lighter soils and sloping ground surface compared to the more flat alluvial plains with heavy soils.

In some places, bunds are so poorly maintained that virtually no water is trapped in the field, and all surface water drains off after precipitation. In others, this was happening because of crab damage to the bund and the belief that the water had to be drained to prevent build up of the crab population. In reality, the crabs need to be controlled and then proper water levels can be maintained. The farmers of the Dolok-Penggaron service area are not informed or attuned to proper water management in rice. This is understandable with their lighter soils and interest in other crops besides rice. See para B.10. for further discussion.

(v) Delay in the Adoption of Cropping Patterns

This area is small and with some slope so it should have less trouble with farmers learning how to distribute water properly. Irrigation will not be completely new in some of the area but changing to multi-rice cropping will require adoption of new practices.

B.6.6.b Yield Projections

Yields are projected for the future without the project and the future with the project and are shown in Table B-3.

Without-project yields are expected to moderately increase from the present levels with the increased use of HYV and the increase in support efforts, i.e. extension, BIMAS and INMAS. A small shift to two crops of rice from one crop is expected in this area. About one-fourth of the one crop area would start growing 2 rainfed crops without irrigation. This shift will be greater in the Lusi and Juana Valleys.

The yields for the future with the project situation are predicted to be slightly higher than for the Lusi Valley. It is a smaller area and closer to input supplies. The predicted yields are lower than for the Tuntang-Jragung project because of the difference in soil, topography and potential flood damage. Some flood control benefits would be derived from the dams of the project but improved drainage will still be needed next to the highway. Future yields expected with the project are given in Table B-3. The yields predicted are average realizing some growers may exceed this level by 15-20 percent but others will use less fertilizer and insect control in the same production and irrigation circumstances.

B.6.6.c. Irrigated Areas

A total area of 6,548 ha is now available for irrigation with none of this now receiving technical irrigation completely. The small area (350-400 ha) mentioned above grows three rice crops but does not have year-round irrigation. With the rehabilitation of the secondary canals in the area and 470 ha of tertiary canals constructed, a total of 50 percent of the area will have run-of-river wet season irrigation. With the proposed storage facilities (Appendix C, Part II) and an adequate distribution system the Dolok and Penggaron Rivers will provide sufficient water to fully irrigate the area (see B.7.9.). The present predicted service area for the Dolok-Penggaron area is given below. This may be changed in the future depending on the extent of housing and industry development in the western portion.

	Ha
Dolok	1,958
Penggaron	4,590
Total	6,548

B.7. IRRIGATION REQUIREMENTS

Up to this portion of Appendix B (Part II), the three service areas have been discussed separately but in the remainder of this Appendix comment will be made on all three service areas under each title or subtitle (when comment is needed or applicable).

B.7.1. General

Comments on Page B-53 of Part I of this Appendix are applicable to all three areas except in the second paragraph where the percentage of tripple cropping is mentioned; these differences for the three service areas covered in Part II can be noted in Tables B-1, B-2 and B-3. Adequate climatological data is not available from the actual service areas to make all necessary irrigation requirement calculations, but what is available (i.e. rainfall, etc.) is used in the same manner as in Part I of this Appendix to obtain all water requirement figures.

B.7.2. Potential Evapotranspiration (PET)

Same values of PET were used in this study as for that reported in Part I because sufficient climatological data were not available.

B.7.3. Land Preparation

Deep percolation losses were estimated for each service area and considerations were made within each area for soil and topography variations. In the Dolok-Penggaron area, about 70 percent of the area is lighter soil and sloping from the hills. Here the deep percolation losses would be at least 2.0 mm/day. The other 30 percent of the area is lower and more flat with heavier soil. Here the losses would be 1.0 mm/day. In the Lusi Valley, 25 percent of the land lies near the river. This soil is lighter textured than that further out in the alluvial plain. Here again, 2.0 and 1.0 mm/day losses were used for the lighter and heavier textured soils, respectively, although surrounded by lighter yellowish to reddish soils. The irrigable portion of the Juana Valley would be the grey to black clays and humus clays in the swamps. These latter soil types would have a low deep percolation rate as shown below.

The average values used for the three service areas are as follows:

	mm/day	mm/month
Dolok-Penggaron	1.70	51.0
Lusi Valley	1.25	37.5
Juana Valley	1.15	34.5

B.7.4. Crop Calendar

Since nearly the same cropping patterns were used for the three service areas as in Tuntang-Jragung, the cropping calendar worked out in detail and given in Figure B-4 of Part I is also applicable. An additional cropping calendar for 2 crops of rice under run-of-river irrigation in the wet season is shown in Figure B-2 of this report.

B.7.5. Crop Water Requirements

Crop water requirements have been calculated in the same manner as in Part I of this Appendix and are reported in Appendix D, Part II.

B.7.6. Cropping Patterns

There are some other possibilities for an earlier start (October) of the rice crop and also shortening the turn around periods. These are used in multiple cropping systems in other parts of Asia. The rice can be seeded in prepared dry seed beds or after the first rains and thus planted in the soil and into moisture. Seedlings would grow under upland conditions until flooded by rain or with irrigation water. The third method is to wait for sufficient rains to work the soil and at or near the surface saturation stage, sow pre-soaked seed. It is preferrable to plant the seed in rows but broadcasting the seed is the more common practice. As would be expected, weed control is a problem with these systems. Weed control materials (machete is most widely used) must be applied but are expensive. The savings in labor and time will offset this expense however. Investigations should be conducted in the service areas to evaluate the possible local adaptability of these methods.

The average monthly project water requirements are presented in Appendix D - Part II.

B.7.7. Effective Rainfall

The statements in Part I of this Appendix, on pages B-59, B-60 are all applicable to three service areas covered in this Part. Additional comments are given in paragraphs under B.10 following.

Twenty-one-year rainfall data was used to compute the effective rainfall for all three areas with the same method described in Part I of this Appendix, page B-60.

B.7.8. Irrigation Demand

The Irrigation demand was computed in the same manner as fo[r] Tuntang-Jragung Subbasins and using the 21-year rainfall data mentioned above. The results are given in Appendix D - Part II.

B.8. SYSTEM CONSTRAINTS TO INTENSIFIED IRRIGATION

Comments found in Section B.5. of Part I of this Appendix are applicable also to Dolok-Penggaron but not to the other two areas since their irrigation systems are yet to be developed. Systems will be planned and designed for providing full irrigation in the dry season as well as the wet season.

B.9. PROBLEMS ASSOCIATED WITH INCREASING CONVEYANCE SYSTEM CAPACITIES

The discussion in the corresponding section in Part I of this Appendix and all comments therein are applicable to Dolok-Penggaron System. Much of the discussion would also apply to any other service area in the Jratunseluna Basin. Certainly design of the system in the Lusi Valley will have problems to properly command all of the service area.

B.10. GENERAL CONSTRAINTS AND CONSIDERATIONS

The predicted cropping with its multiple rice cropping on a total of 50,373 ha would produce over 590,000 tons of rice annually. This is more than a four-fold increase over the present production of 142,000 tons. At the level of this study, irrigation requirements and cropping have been mostly dealt with. Further studies will need to seriously deal with all the infrastructure, facilities, roads, etc. that are necessary to handle this sizable amount of rice and its associated requirements. This and other general constraints to the over all development of project are discussed below.

B.10.1. Water Management

Farmers in the area do not have a concept of managing water in a rice field to their own benefit. If the surface is saturated or there is some standing water, this is considered satisfactory. It is desirable for transplanting but growing rice as it develops can benefit from water depths of from 4 to 16 cm depending on the height of the rice. Maintaining water levels so that excess water drains out at fixed or variable levels can immensely improve the efficiency of use of irrigation water and also have a large impact in reducing flood problems. If every farmer in a given area could let sudden heavy rains build up in his paddy by 10 cm, not endangering the rice, and release the excess gradually, it would be very effective in reducing flood potential for the entire area.

Trapping rain water in the paddy to a depth the rice can tolerate instead of constantly draining it off would increase the effectiveness of rainfall to the crop and reduce the irrigation water that would later be required. Universal practice of this would improve the efficiency of any given irrigation system and increase the area that it could serve.

Constant levels of 5 to 12 cm water on growing rice help control weeds and lessen the problem of loss of nitrogeneous fertilizers by denitrification.

For improved on-farm water management, farmers will need to have adequate maintenance of bunds, increase their sizes in some cases, and control crabs where they are a problem.

Problems of delivery of water by the irrigation system and of distribution at the sub-tertiary level needs to be attacked systematically by the irrigation department. Facilities will be needed to regularly train water management technicians to work in the field with the farmers, PPL's and other support programs in the area. The "out in the field" farmer contact by the PPL's under the National Flood Crops Extension program is proving successful because regular training and visitation are required and a similar program with Water Management technicians is needed. Coordination and working together of all the agencies involved in agriculture would result in benefits to the farmer and the agriculture of the area. Presently, some agencies are not even aware of the existence and, therefore, the functions of other agencies.

B.10.2. Mechanization

Looking forward to the predicted cropping pattern, there is a need to develop information on methods that the Indonesian culture could adopt in mechanization of phases of rice culture. It would need to not only be economically feasible but also socially acceptable.

Mechanization deserves study because with the project a large area with sizable production is involved where multiple cropping demands will magnify present needs. It is recognized that the labor supply is adequate and low cost but with multiple cropping over a large area, timing may become a critical factor. Turn around time between rice crops must be kept to a minimum to maintain the crop production potential as envisioned. It is also important to improve the efficiency of water delivery by the irrigation system.

Agriculturists who have been busy with crop varieties, fertilization and pest control should also look to small machinery testing and demonstrations with farmers. If farmers see the equipment in operation and feel that it is affordable they will adopt it. With the small farm size in the area, this may take collective or cooperative effort which is many times difficult with farm people. Researches and extension will need financial support in studying and demonstrating farm mechanization. Support from an international organization like IRRI may be available for assistance in such a program.

A few pedal threshers are in the area but at present very little mechanization exists. The IRRI type small thresher, which can be carried from field to field, should be demonstrated. Hand tractors for land preparation would speed up and improve this operation in the turn around period between crops.

B.10.3 Crop Drying

With all the 2-, 2½- or 3-rice crop systems, at least one crop will be maturing during the wet season. The present volume of crop suffers some losses from wet weather at harvest and drying time but the present methods of handling the crop will be inadequate with the volume predicted in the future. There will be a need for more and larger drying flows. This alone will not be the solution, however, the small IRRI batch dryer should be demonstrated to small villages or groups of farmers. A pilot project with silo bin dryers in the

10- to 30-ton capacity range would be useful. These could be set up in larger village or center locations. There are two types, batch dryers and those that can auger the rice during drying. These should be government sponsored in the beginning. The private sector may take the lead after farmer acceptance and their realization that the economics are favorable. But Government would also need to be involved to meet the heavy demand expected of the equipment.

B.10.4. Processing and Storage

The present rice processing facilities are characterized by small mills widely scattered throughout the area. Although they are operating to full capacity now, they would be inadequate in the future with the project and the production it would generate. Pilot projects with 8 to 10-ton capacity mills with storage should be set up before project completion. Studies should be made now where larger mills would be needed by the time of full production in the project area.

With the prospect of 540,000 tons being produced annually in the project area, radical changes will be needed in the present practices and concepts of rice storages. Large centralized warehouses would take the rice out of the hands of farmers and reduce the rodent and insect losses now being experienced. These would probably have to be built and run by the Government. The private sector has not shown inclinations towards undertakings of this size.

B.10.5. Transport

Roads are inadequate in the area and many are poor and impassable in wet weather. New roads will be needed in the central part of the Juana Valley when it is opened up. Crop inputs into and crop production out of the area on the volume predicted with the project would require vastly improved roads to avoid costly delays and difficulties.

An area such as this with the value of its increased production should get the attention of the Government and help in road projects. The chances of this being done is not known at present but should be investigated in future project planning.

B.10.6. Research

IR36 variety of rice is getting rapid and widespread acceptance wherever introduced in the area. The early maturity and good yielding ability of this type fit well into multiple rice cropping. The brown plant hopper resistance of IR36 makes it a valuable asset to the area. Researchers should continue to test other varieties with BPH resistance and early maturity keeping in mind the dangers inherent to becoming a one-variety area.

All of the area is broadcast on the surface of the soil. Nitrogen losses are experienced when the fertilizer is applied in this manner. The losses could be as high as 30 to 40 percent. Placement of the fertilizer 3 to 4 cm into the saturated or flooded soil prevents such losses. Research should find a practical method of doing this and then demonstrate it to the farmers. Assuming 20 percent loss as average the growers would be using 300 kg urea per crop three times a year on 71 percent of the project lands (50,000 ha). By proper placement of fertilizer, 6,400 tons of fertilizer could thus be saved. The farmers could use that much less and get the same yields or use the 300 kg/ha rate and get more rice. The increased value of the rice would probably be greater than the value of the fertilizer saved. In this case, it would be easy to put a Rupiah value on the results of research and extension should they be successful in promoting a solution to this problem.

TABLE B-1

LOWER AND MIDDLE LUSI

TUNTANG AND RELATED RIVERS BASINS DEVELOPMENT PLAN

SUMMARY OF CROPPING PATTERNS, YIELDS, PRODUCTION

	Present	Future Without	Future With
Gross Area	19,725	19,725	19,725
Irrigable Area	13,825	13,825	13,825
Area Irrigated	2,000 1)	2,000 1)	13,825 2)

CROPS	PRESENT					FUTURE WITHOUT					FUTURE WITH (P)					FUTURE WITH (R-R)				
	% Area	% HYV-LV	Area (ha)	Yield t/ha	Prod. ('000 t)	% Area	% HYV-LV	Area (ha)	Yield t/ha	Prod. ('000 t)	% Area	% HYV-LV	Area (ha)	Yield t/ha	Prod. ('000 t)	% Area	% HYV-LV	Area (ha)	Yield (t/ha)	Prod. ('000 t)
SURJAN 3)	2		553			2		553			2		553			2		553		
Maize	(54)		(299)	1.0	0.30	(54)		(299)	1.2	0.36	(48)		(265)	1.5	0.40	(48)		(265)	1.5	0.40
Soybean	(18) I		(100) I	0.9	0.09	(18) I		(100) I	0,9	0.90	(14) I		(77) I	1.0	0.07	(14) I		(77) I	1.0	0.07
Tobacco	(15)		(83)	0.6	0.05	(15)		(83)	0.6	0.05	(20)		(111)	0.7	0.07	(20)		(111)	0.7	0.07
Rice	(15)	LV	(83)	2.0	0.17	(15)	HYV	(83)	3.6	0.30	(15)	HYV	(83)	3.6	0.30	(15)	HYV	(83)	3.6	0.30
Cassava	(16)		(88)	6.5	0.57	(16)		(88)	6.5	0.57	(17)		(94)	7.0	0.66	(17)		(94)	7.0	0.66
1 RICE CROP (HYV)	17	(50)	1,175	3.3	3.88															
(LV)		(50)	1,175	2.0	2.35															
2 RICE CROP (HYV)	1	(100)	276	3.3	0.91	35	(100)	4,838	3.6	17.42						48	(90)	11,945	3.8	45.39
(LV)																	(10)	1,327	2.2	2.92
2½ RICE CROP (HYV)																				
(LV)											14	(100)	4,839	4.5	21.78					
3 RICE CROP (HYV)																				
(LV)											71	(100)	29,447	4.3	126.62					
1 RICE CROP (HYV)	80	(50)	5,530	3.3	18.25	63	(75)	6,532	3.6	23.52						33	(90)	4,106	3.8	15.60
(LV)		(50)	5,530	2.0	11.06		(25)	2,178	2.2	4.79							(10)	456	2.2	1.00
Palawija																				
Maize	(200)		22,120	1.3	28.76	(200)		17,420	1.5	26.13						(200)		9,125	1.7	15.51
Soybean	(100) I		(11,060)	0.9	9.95	(100) I		(8,710)	1.0	8.71						(100) I		(4,562)	1.2	5.47
2 RICE CROP (HYV)											13	(90)	3,235	4.5	14.56	17	(90)	4,230	3.8	16.07
(LV)												(10)	360	2.5	0.90		(10)	470	2.2	1.03
Palawija																				
Maize											(100)		1,797	1.6	2.88	(100)		2,350	1.8	4.23
Soybean											(75) I		(1,348)	1.2	1.62	(75) I		(1,763)	1.1	1.94
TOTALS	100		36,359			100		31,521			100		39,954			100		33,870		
AREA CROPPED			13,825					13,825					13,825					13,825		
CROPPING INTENSITY			2.63					2.28					2.89					2.45		

Note: In the column "% Area", those figures in paranthesis and percentages of that area under which they are shown and not of the total area. The capital letter "1" devotes intercropped in crop immediately above and is not counted as part of the total area cropped.

1) Run of the river, wet season only.
2) All of the area considered as in 2 possible situations. Shown below in the future with the project as (P) - perennial year round irrigation and (R-R) Run of the river wet season only.
3) Surjan is taken as 2.0 cropping intensity. All crops within surjan show the same intensity but in reality it is complicated because of intercropping and would be difficult to depict in this table.

TABLE B-2

JUANA VALLEY

TUNTANG AND RELATED RIVERS BASINS DEVELOPMENT PLAN

SUMMARY OF CROPPING PATTERNS, YIELDS, PRODUCTION

	Present	Future Without	Future With
Gross Area	36,000	36,000	36,000
Irrigable Area	24,000	24,000	30,000 2)
Area Irrigated	2,100	2,100 1)	30,000

CROPS	PRESENT					FUTURE WITHOUT					FUTURE WITH				
	% Area	% HYV-LV	Area (ha)	Yield t/ha	Prod. ('000 t)	% Area	% HYV-LV	Area (ha)	Yield t/ha	Prod. ('000 t)	% Area	% HYV-LV	Area (ha)	Yield t/ha	Prod. ('000 t)
SINGLE CROP															
Cassava 3)	9		4,320	9.0	38.88	9		4,320	9.5	41.04	5		3,000	11.0	33.00
Maize	2		480	1.2	0.58	2		480	1.3	0.62					
(Soybean)	(50)I		(240)	0.7	0.17	(50)I		(240)	0.8	0.19					
1 RICE CROP (HYV)	31	(10)	744	3.5	2.60	31	(20)	1,488	3.8	5.65					
(LV)		(90)	6,696	2.0	13.39		(80)	5,952	2.1	12.50					
2 RICE CROP (HYV)	19	(100)	9,120	3.3	30.10	36	(100)	17,280	3.6	62.21					
(LV)															
2½ RICE CROP (HYV)											14	(100)	10,500	4.5	47.25
(LV)															
3 RICE CROP (HYV)	9		6,480	3.6	23.33	9	(100)	6,480	3.8	24.62	71	(100)	63,900	4.3	274.77
(LV)															
1 RICE CROP (HYV)	30	(50)	3,600	3.3	11.88	13	(75)	2,340	3.6	8.42					
(LV)		(50)	3,600	2.0	7.20		(25)	780	2.2	1.72					
Palawija															
Maize	(83)		6,000	1.1	6.60	(77)		2,400	1.3	3.12					
Soybean	(47)I		(3,360)	0.8	2.69	(38)I		(1,200)	0.9	1.08					
2 RICE CROP (HYV)											10	(90)	5,400	4.5	24.30
(LV)												(10)	600	2.5	1.50
Palawija															
Maize											(100)		3,000	1.7	5.10
Soybean											(80)I		(2,400)	1.1	2.64
TOTALS	100		41,040			100		41,520			100		86,400		
AREA CROPPED			24,000					24,000					30,000		
CROPPING INTENSITY			1.71					1.73					2.88		

Note: In the column "% Area", those figures in parenthesis are percentages of that area under which they are shown and not of the total area. The capital letter "I" denotes inter-cropped in crop immediately above and is not counted as part of the total area cropped.

1) Run of the river wet season irrigation, 1,300 ha. Full irrigation, 800 ha.
2) Additional area as a result of reclamation of swamps (6,000 ha).
3) Cassava represents several crops in the pattern (including vegetables). The intensity of cropping is assumed to be 2.0 because of all the inter-cropping involved.

B-60

TABLE B-3

DOLOK - PENGGARON

TUNTANG AND RELATED RIVERS BASINS DEVELOPMENT PLAN

SUMMARY OF CROPPING PATTERNS, YIELDS, PRODUCTION

	Present	Future Without	Future With
Gross Area	11,450	11,450	11,450
Irrigable Area	6,548	6,548	6,548
Area Irrigated	3,000 1)	4,500 2)	6,548 3)

CROPS	PRESENT					FUTURE WITHOUT					FUTURE WITH				
	% Area	% HYV-LV	Area (ha)	Yield t/ha	Prod. ('000 t)	% Area	% HYV-LV	Area (ha)	Yield t/ha	Prod. ('000 t)	% Area	% HYV-LV	Area (ha)	Yield t/ha	Prod. ('000 t)
SURJAN 4)	18		2,357			20		2,619			5		654		
Maize	(26)		(613)	0.9	0.55	(26)		(681)	1.0	0.68	26		(170)	1.5	0.26
Soybean	(6) I		(141) I	0.7	0.10	(6) I		(157) I	0.7	0.11	(6) I		(39) I	1.0	0.04
Tobacco	(33)		(778)	0.6	0.47	(33)		(864)	0.6	0.52	(33)		(216)	0.7	0.15
Paddy	(15)	LV	(353)	1.9	0.67	(15)	HYV	(393)	3.0	1.18	(15)	HYV	(98)	3.5	0.34
Cassava	(26)		(613)	4.2	2.57	(26)		(681)	4.2	2.86	(26)		(170)	4.5	0.77
1 RICE CROP (HYV)	38	(50)	1,244	3.0	3.73	26	(85)	1,447	3.3	4.78					
(LV)		(50)	1,244	1.9	2.36		(15)	255	2.0	0.51					
2 RICE CROP (HYV)						10	100	1,310	3.3	0.43					
(LV)															
2½ RICE CROP (HYV)															
(LV)											14	(100)	2,292	4.6	10.54
3 RICE CROP (HYV)	6	100	1,200	3. 5	4.2	6	100	1,200	3.8	4.56					
(LV)											71	(100)	13,947	4.4	61.37
1 RICE CROP (HYV)	38	(50)	1,244	3.0	3.73	38	(75)	1,866	3.3	6.16					
(LV)		(50)	1,244	1.9	2.36		(25)	622	2.0	1.24					
Palawija															
Maize	(75)		1,866	0.9	1.68	(75)		1,866	1.0	1.87					
Soybean	(25) I		(622) I	0.7	0.44	(33) I		(622) I	0.7	0.44					
2 RICE CROP (HYV)															
(LV)											10	(90)	1,310	4.6	6.03
Palawija												(10)	65	2.5	0.16
Maize											(100)		654	1.7	1.11
Soybean											(75) I		(491) I	1.0	0.49
TOTALS	100		10,399			100		11,185			100		18,857		
AREA CROPPED			6,548					6,548					6,548		
CROPPING INTENSITY			1.59					1.71					2.88		

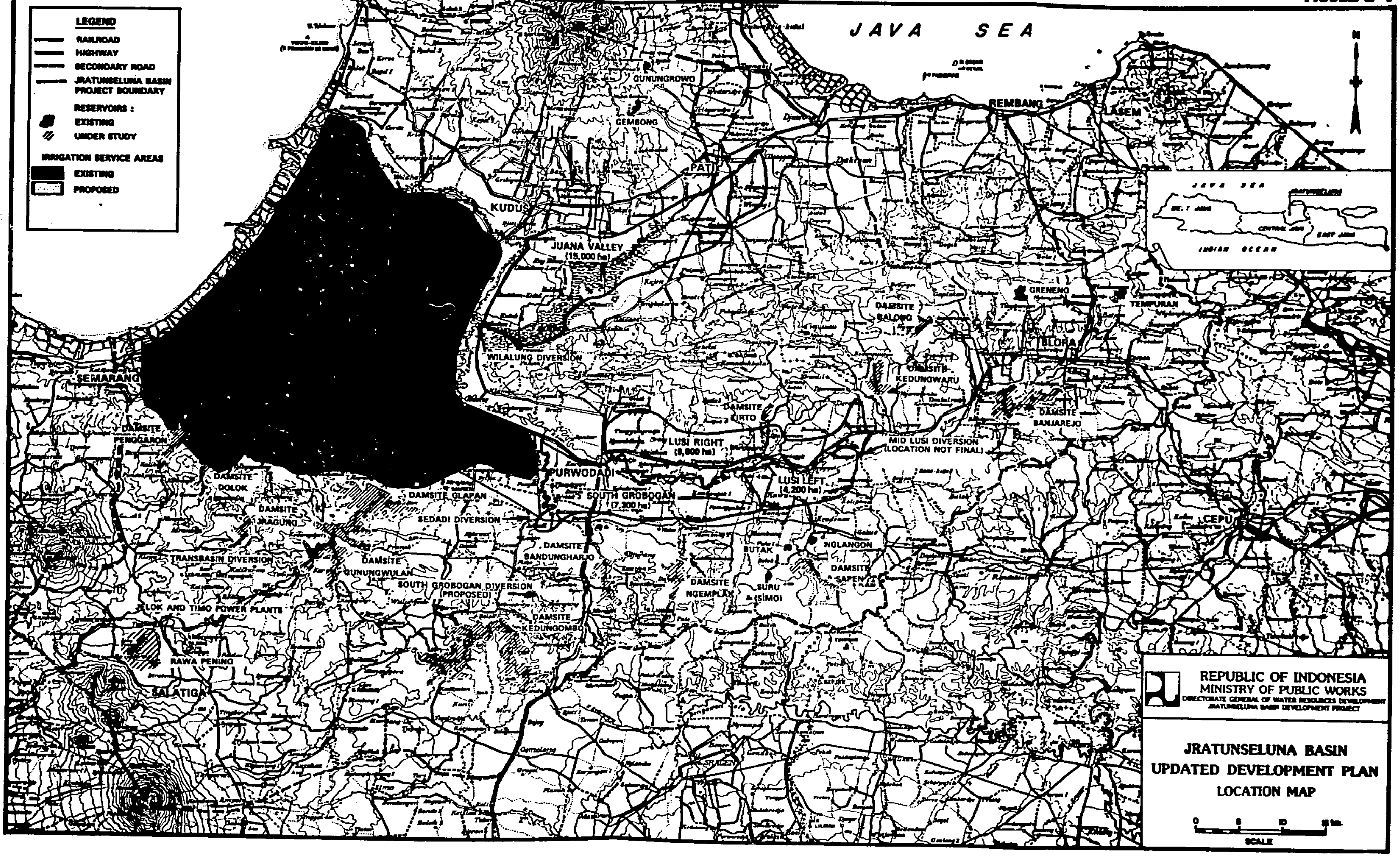
Note: In the column "% Area", those figures in parenthesis are percentages of that area under which they are shown and not of the total area. The capital letter "I" denotes inter-cropped in crop immediately above and is not counted as part of the total area cropped.

1) Run of the river wet season only. 400 ha grows three rice crops
2) Same. Additional area a result of rehabilitation project
3) Perennial or year-round irrigation
4) Surjan is taken as 2.0 cropping intensity. All crops within Surjan show the same intensity but in reality it is complicated because of inter-cropping and would be difficult to depict in this Table.

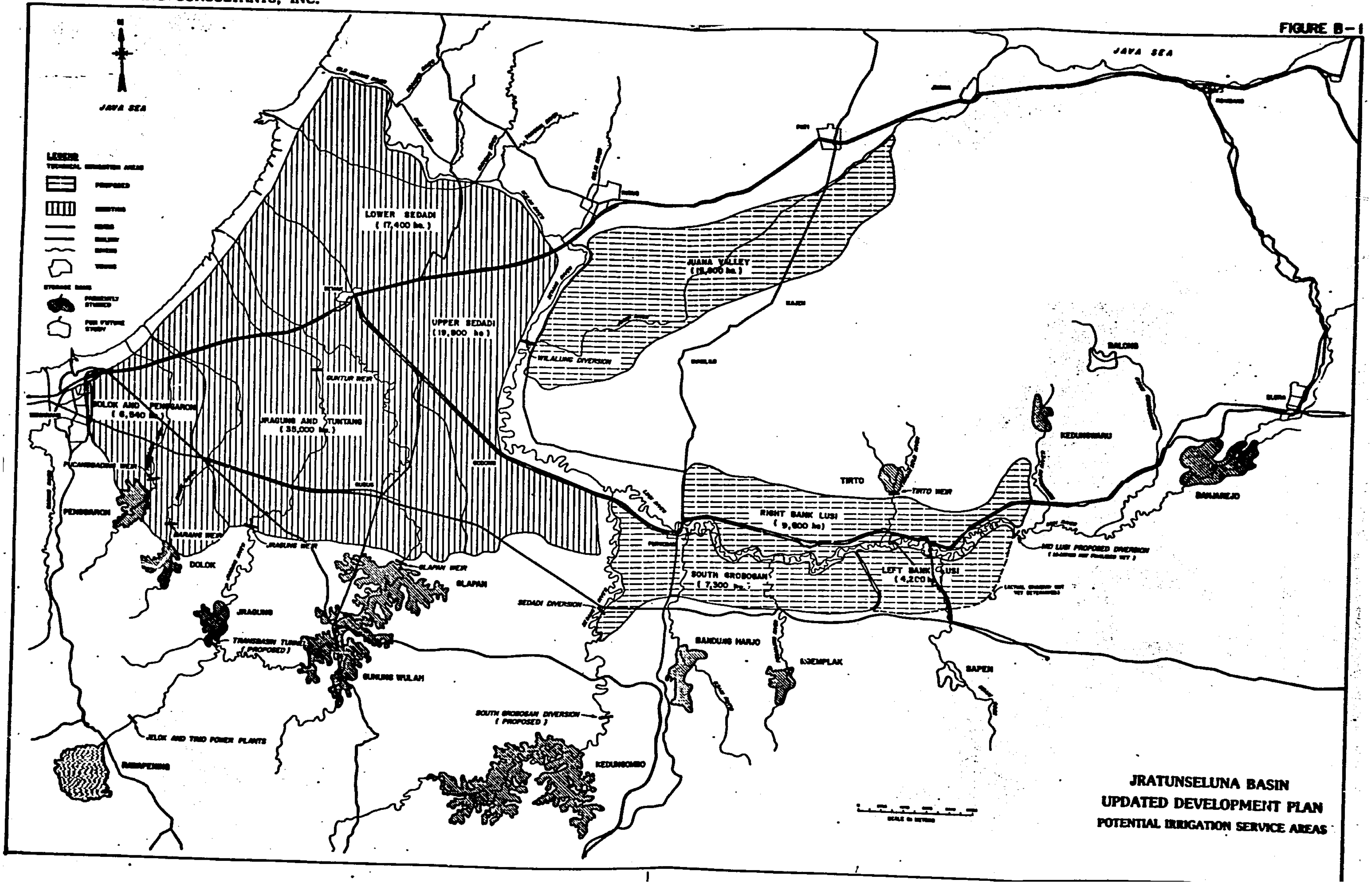
BIBLIOGRAPHY

No.	Title
1	NEDECO, "Jratunseluna Basin Development Project, Feasibility Study Jragung, Dolok and Penggaron Basins, December 1971
2	Snowy Mountains Engineering Corporation, "The Improvement and Development of the Serang River and Irrigation Project, Central Java. South Grobogan Irrigation Project Feasibility Study, Summary", February 1980.
3	Snowy Mountains Engineering Corporation, "The Improvement and Development of the Serang River and Irrigation Project, Central Java. South Grobogan Irrigation Project, Feasibility Study, Technical Report", June 1978.
4	Snowy Mountains Engineering Corporation, "Juana Valley Irrigation Project - Feasibility Study", February 1980.

FIGURE II-1

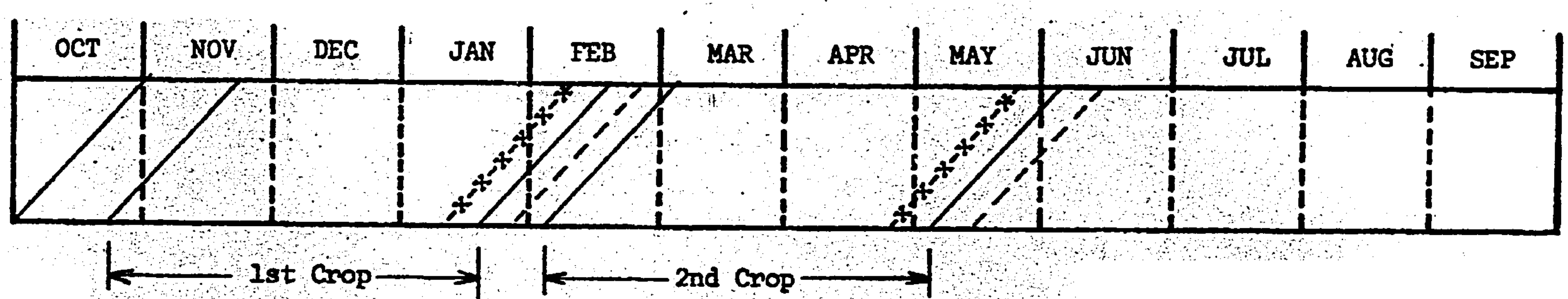

LEGEND
RAILROAD
HIGHWAY
SECONDARY ROAD
JRATUNSELUNA BASIN PROJECT BOUNDARY
RESERVOIRS :
EXISTING
UNDER STUDY
IRRIGATION SERVICE AREAS
EXISTING
PROPOSED
JAVA SEA
GUNUNGROWO
GEMBONG
REMBANG
LASEM
PATI
KUDUS
JUANA VALLEY (15,000 ha)
GRENENG
TEMPURAN
DAMSITE BALONG
BLORA
WILALUNG DIVERSION
SEMARANG
DAMSITE KEDUNGWARU
DAMSITE KIRTO
DAMSITE BANJAREJO
DAMSITE PENGGARON
LUSI RIGHT (9,800 ha)
MID LUSI DIVERSION (LOCATION NOT FINAL)
PURWODADI
LUSI LEFT (4,200 ha)
DAMSITE DOLOK
DAMSITE GLAPAN
SOUTH GROBOGAN (7,300 ha)
DAMSITE JRAGUNG
SEDADI DIVERSION
CEPU
DAMSITE BANDUNGHARJO
BUTAK
NGLANGON
TRANSBASIN DIVERSION
DAMSITE GUNUNGWULAN
DAMSITE SAPEN
SOUTH GROBOGAN DIVERSION (PROPOSED)
DAMSITE NGEMPLAK
SURU (SIMO)
JELOK AND TIMO POWER PLANTS
DAMSITE KEDUNGOMBO
RAWA PENING
SALATIGA
JAVA SEA
INDIAN OCEAN
REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
JRATUNSELUNA BASIN DEVELOPMENT PROJECT
JRATUNSELUNA BASIN
UPDATED DEVELOPMENT PLAN
LOCATION MAP
0 5 10 15 km.
SCALE

PRC ENGINEERING CONSULTANTS, INC.



TWO RICE CROPS GROWN IN WET SEASON

RUN OF THE RIVER IRRIGATION



————————	Plant to start of Harvest
-x-x-x-x-x-	Suspension of Irrigation (15 days before harvest)
-----------	End of Harvest (10 day period - 1st crop)
L-P	Land Preparation

TUNTANG AND RELATED RIVERS
BASINS DEVELOPMENT PLAN

CROPPING CALENDAR FOR
RUN-OF-RIVER IRRIGATION

PRC ENGINEERING CONSULTANNTS, INC

FIGURE B-2