13.1.3 Cultivation Test

According to the results of soil cultivation test in the projected pilot farm area (Table 13.2), it is estimated that soil cultivation will not be difficult because the soil conditions after construction of irrigation and drainage facilities will be improved. However, the result of testing shows that cracked soil area in the dry season will require some pre-watering for ploughing and/or harrowing.

13.1.4 Farming Conditions

The paddy cultivation practices such as puddling, levelling, planting, fertilizing, plant protection and weeding are usually implemented in the muddy wet field. However, mechanical operation under said conditions in the project area will be low efficiency and/or difficult due to the soil characteristics as mentioned before.

Thus, proposed cultivation practices except for up-keeping of rice plant will performed under dry soil conditions. Land preparation and sowing will be very similar practices to those for up-land crops. However, ploughing, harrowing, land levelling, sowing and water control will be carried out more carefully to keep good germimation and growth of the paddy.

13.2 Selection of Farm Machinery and Vehicles

The selection of farm machinery to be used was made in due consideration of the local climate and soil conditions in the project area, the proposed works and those practices, furthermore, the experiences of prevailing farm mechanization in the Sudan and other countries.

13.2.1 Tractors

Four-wheel type of tractors in 75 ps class are selected as the master power in this programme. This type of tractors are most popularly introducing in the country at present in spite of high population of 60 ps class tractors. This tendency is as same as world trend due to the requirement of high efficiency of higher horsepower machinery and labor saving point of view. Furthermore, the land preparation in the dry paddy field is required at similar operations with up-land cultivation using higher horse power. From the repair and maintenance point of view, assembling the project of this type of tractors which will be implemented soon at Sennar would be helpful in the future.

In some area where the soils are very firmly consolidated and/or wet due to comparatively uneffective drainage, small crawler tractors (60 ps class) will be required to the supplementary operations of wheel tractors.

13.2.2 Attachments

As for the elementary attachments to the tractors, the following type and size are selected on the basis of the experiences on hard soil in the Sudan.

For ploughing: Chisel plough having 7 to 9 shanks will be used for this purpose.

For harrowing: Offset disc harrow which consists of two gangs. Front gang will be equipped with 9 to 12 numbers of notched type disc, while same numbers of plate type disc in rear gang. Each disc will be 22 to 24 inches in diameter and will have scraper individually. Cutting width will be 8-10 feet.

In addition to the above, rotarvater is proposed for final soil preparation. The rotary harrowing is not popularly practised in the Sudan at present, but it will be much applicable for prepartion of good seed bed. For this purpose, rotarvater having 2 m of working width is proposed.

Prior to the rotary harrowing, application of urea and triple-super phosphate as the basic fertilizer is scheduled on the farm operation programme. For this practice, broadcaster having 400 liters in tank capacity will be used.

After completion of all the above, arrangement of temporary field ridges and final levelling of seed bed will be carried out by the use of the following equipment attached to the tractor.

For ridging work: One-row ridges which is commonly used in the Sudan, at present.

For final levelling: Grader with 3 m width.

As stated in Chapter 13.1.1, seeding under submerged condition is not suitable practice in this area. Thus, it is recommended to sow the seeds on dry field where soils have a moisture contents at field capacity. In operation of this practice, the following type of drill seeder will be applicable.

Drill seeder - level disc harrow with 12 to 15 feet in width, which have 24 to 30 numbers of discs.
- trush guards with disc of 18 to 20 inches in diameter.
- 24 to 30 numbers of seeder boxes.

For clearing of rice straw, rear-mounted disc mower and side delivery rake will be introduced after the harvesting. Those rice straw will contribute the animal grazing in and around the project area.

As for the transportation of rice straw from field to outside of the project area, some 5 tons in capacity of trailer will be used.

13.2.3 Combine Harvester

The grain combine harvester is broadly classified into two types by the mechanical difference on threshing unit. One is the bar type thresher which is now prevailing in the Sudan for harvesting the wheat. The other one is equipped with tooth type thresher. In the consideration of relatively high shattering characteristics of rice, latter one is applicable for rice harvesting. The following type of combine harvester is selected:

Horsepower; 100 ps
Cutting width; 4 to 4.5 m
Thresher; tooth type
Capacity of grain tank; 3,500 liters
Trafic; Semi-crawler (changeable to wheel)

To minimize labour, equipment and materials, and also to operate a functionable receiving of the products at rice mill, transportation of rice grains by bulk loading system would be applicable. For this purpose, combine harvester will be equipped with the grain tank in capacity of 3,500 liters.

The harvesting will be usually carried out after 15 days from the drainage operation. The traficability of the combine harvester will be satisfaction. According to the experiences in Malaysia, where the soils have similar characteristics as those in the project area, the submerged soils have shown still more than 5 kg/cm^2 of cone resistance values after 7 to 10 days from the completion of drainage operation.

13.2.4 Equipment for Other Works

As for the additional application of fertilizers, chemicals for plant protection and weed control, an aerial spraying by air-craft and/or traditional ground spraying by small unit of machinery are generally used in large scale of the rice production programme.

Recently in the Sudan, the aerial spraying by the use of air-craft has been practised under the overall plant protection programme provided by the Directrate of Plant Protection, Ministry of Agriculture, Food

and Natural Resources. The present spraying charges inclusive of chemicals are estimated at about £s 7.10 per ha per one time. It will be rather costly as compared with the charges estimated by the traditional method which is being commonly conducted on rice cultivation in Gezira as shown below:

Cost of Chemical Spraying

	(Unit: £s/ha/one time)
Aerial spraying by air-craft	7.10
Spraying by traditional method	5.95

Data: Annual report on economic surveys, the Planning and Development Department, Sudan Gezira Board (1975/76).

Besides, as far as rice cultivation foreseen in the project area are concerned. The aerial spraying by air-craft will be unsuitable from the following reasons:

1) Effective distribution of chemicals will not be expected because of the suitable flying altitude might be limited by wind-breaker in future.

2) Flying on suitable course will be difficult to estimate in the project area due to narrow extent.

3) Operation will be limited by wind velocity, e.q. critical velocity is estimated at 3 m/sec for spraying the powder and 5 m/sec for liquid type of chemicals (In this programme, powdery and/or granular chemicals will be regularly used, in due consideration of the low relative humidity in most of the season).

Herein the proposed works, therefore, undertaken by the traditional ground spraying method. In this connection, power duster equipped with long application pipe is selected in due consideration of the field conditions to be mostly under the stagnent water. The power duster will be able to spray out such powdery or granular type of fertilizers and agro-chemicals for about 40 m far from the farm road or field ditch.

Liquid spraying will be conducted by the use of knapsack type sprayer, but it will only provide for an emergency measures and/or spot happening with insect or plant diseases.

13.2.5 Vehicles

The dump-trucks will be used as the main transportation facility of farm inputs and farm products. In due consideration of the farm road conditions designed in Annex X, some 4-ton in class of dump-truck is proposed.

13.3 Required Numbers of Farm Machinery and Vehicles

The numbers of farm machinery are studied on the basis of the operation programme, workability specified in each machinery, and workable days to be estimated hereinunder.

13.3.1 Estimation of Workable Days and Working Hours a Day

The weather conditions were checked in connection with the workable days in the field operation. According to the data of rainfall in the past 30 years, some 50% of days being over 10 mm precipitation per day are assumed as unworkable days. Furthermore, the National holiday and Friday will be estimated at 5 days per month. The workable days by month are shown in Table 13.3.

It is assumed that the daily working hours are estimated at 14 hours in the normal conditions in which two shifts operation by 7 hours in unit is programmed. While one operation by 7 hours is only possible in the fast month (so-called Ramadon). Monthly distribution of workable days and total workable hours per month are as follows.

Workable Day and Working Hours
Estimated by Month

Month	J	F	M	A	M	J	J	A	S	O	N	D	Total
Workable days	26	24	26	25	26	25	23	22	24	26	25	26	298
Working hours	312	288	312	300	312	300	276	264	144 /1	312	300	312	3,576

Note: /1 estimated by 6 hr/day in working hours due to Ramadon.

13.3.2 Working Capacity and Working Efficiency in Each Machinery

Actual field working capacity and working efficiency in each ploughing, harrowing and ridging are directly estimated on the basis of the results of various soil cultivation trials made by the Engineering Affairs Administration, Ministry of Agriculture, Food and Natural Resources, Sudan. While, owing to limited experience on other machinery particularly on the rice cultivation. The conditions of these machinery and equipment are estimated by the reference available in case of rice cultivation in large scale in Japan. The conditions estimated in each machinery and equipment are as shown in Table 13.4.

13.3.3 Required Numbers of Tractor and Combine Harvester

In order to determine the most appropriate and economical number of tractor and combine to be used, a comparative study was made on the following alternatives.

(A) Alternative I

(i) Cropping pattern

The 1st crop will be sown from 10th February to 9th March and harvested in June. The 2nd crop will be sown from 5th July to 4th August and harvested during from middle of November to middle of December.

(ii) Working conditions

The working hours per day are assumed at 14 hours, of which one hour for lunch time and one hour for travelling from tractor pool to field are estimated as the waste times. Thus, net field working hours are 12 hours per day.

The combine harvester will be possible to be operated by 12 hours per day owing to the low humidity conditions.

(iii) Required numbers of tractor and combine harvester

Taking into consideration of the actual field capacity of the selected machinery and other factors as mentioned before, the required numbers of major farm machinery in one operation group are estimated in Table 13.5 and Fig. 13.1.

According to the Table, working capacity of one combine harvester and 4 tractors meets with about 240 ha. It corresponds to 300 plots in the smallest plot of 0.8 ha (2 fedd). Therefore, the total planting area of 15,600 ha (about 37,143 fedds) will be cultivated by 260 tractors and 65 combine harvesters.

(C) Alternative II

(i) Cropping pattern

The 1st crop will be sown between 10th February and 6th March, and harvested from 1st June to 15th July. The 2nd crop will be sown from 15th July to 31st August, and harvested from 25th November to 5th January.

(ii) Working conditions

Basically, the net field working hour is assumed at 12 hours as same as Alternative I.

(iii) Required numbers of tractor and combine harvester

The required numbers of tractor and combine harvester are estimated in Table 13.6 and Fig. 13.2. According to the Table, 400 ha will be covered by one combine harvester and 5 tractors. Thus, total area will be cultivated by 195 tractors and 39 combine harvesters.

(D) Alternative III

(i) Cropping pattern

The 1st crop will be sown between 9th February and 11th April, and harvested in June and July. The 2nd crop will be sown in July and August, and harvested from middle of November to beginning of January.

(ii) Working conditions

Basically, the net field working hours are assumed at 12 hours as same as Alternative I.

(iii) Required numbers of tractor and combine harvester

The required numbers of tractor and combine harvester are estimated in Table 13.7 and Fig. 13.3. Regarding to the Table 485 ha will be covered by one combine harvester and 8 tractors as the unit operation group. Therefore, some 32 combine harvesters and 256 tractors are required for the total area.

Table 13.8 shows the results of the comparison in each alternative. As seen in the Table, high investiment cost and O/M cost are estimated in the alternative I. It is mainly by the numbers of tractor required due to the tight work schedule. The alternative II and III are estimated almost same on the investiment cost and O/M cost. In the condition estimated in the alternative III, however, harvesting will be restricted by the rain in the second half of July. The numbers of tractor required are also large as compared with that in the alternative II because of the over-upping works owing to the long work duration. To avoid such conditions, the alternative II is taken into account the proposed mechanization programme.

13.3.4 Required Numbers of Farm Machinery

Based on the conditions presented hereinabove, numbers of machinery and equipment required in this farm operation programme are estimated as shown in Table 13.6. In this estimation, some 400 ha of irrigation block corresponding to 20 irrigation units (each unit has 20 ha in acreage commanded by one on farm ditch) is tentatively defined as the unit acreage for machinery operation. This, as a whole, 39 units of operation group are organized in this programme. In addition to the above, some 15 wheel tractors, 4 combine harvestors, 12 power dusters and 7 dump-trucks are estimated as the stand-by. Besides, 25 clawler type tractors are also estimated for the soil preparation works, particularly in the low-lying area where the field condition mihgt be muddy.

13.4 Operation and Maintenance

13.4.1 Fuel Consumption and Fuel Supply

The fuel consumption is estimated on the basis of the total operation hour estimated in each work item, and unit fuel consumption and load factor defined in each machine. Annual fuel consumption is about 44,800 liters as estimated in Table 13.9. Out of the total consumption, estimated about 15,000 liters of fuel will be required during the harvesting work and soil preparation for next cropping, as the peak consumption. In order to ensure the smooth operation of both harvesting and soil preparation works, at least ten days' consumption of the peak consumption (say 3,300 liters) shall be stocked in the farm because of the conditions of fuel supply to be largely interrupted by the local climate, particularly in the rainy season of July and August. The fuel storage will be installed at 5 locations nearby the rice mill in each tract which commands 7 to 8 operation units and the capacity required is about 30,000 liters in each. As for the fuel supply from the storage to the machinery, fuel tanker having some 3,000 liters in capacity will be provided in each storage.

13.4.2 Labour Requirement on Field Operation

The proposed machinery operation will much minimize the labour force for hand working. In the operation for unit acreage (400 ha), some 8 operators and 14 assistant operators will be regularly required for the machinery operation, as shown in Table 13.10. Besides, some 4 labourers will be required for the relating works on the machinery operation.

As for the relating works particularly to the harvesting some 580 man-day per year of seasonal labour will also required, in addition to the above regular labour, as shown in Table 13.10.

13.4.3 Workshop

The project has many kinds of farm machinery, vehicles, rice mills and other related equipment and tools. For the efficient operation, and repair and maintenance of these mechanical facilities, the workshop will be provided in the project area.

The workshops will be organized by a central workshop with heavy repair facilities and four branch workshops with light repair facilities. Each workshop has appropriate facilities for repair and maintenance and vehicles for field services.

The workshops will be located in each tract and be nearby the rice mill and/or parking areas for engine mounted machinery. Outline of the workshop is indicated in Table 13.11.

Table 13.1 Establishment of Nursery under Different Seeding Conditions

Seeding Conditions	Proportion of seed germination (%)
- Drill seeding on the dry field	92.3
- Broadcasting on the dry field	90.6
- Broadcasting on the moistened field/1	90.8
- Broadcasting on the submarged field/2	67.2

Note: Figures are estimated on the basis of the results of the seeding test by different practices made in the experimental work at Ed Dueim in June, 1977.

/1: Moistened field condition means that the soils are just saturated by the water.

/2: Submerged field condition is that the nursery bed is submarged under irrigation water at the depth of about 1 cm. The soils are completely puddled.

Table 13.2 Cultivation Test

Date : 20 June, 1977

Time : 7.00 - 9.00 a.m.

Place : Projected Pilot Farm Area

Machinery: Borrowed from Agricultural Corporation (Ed Dueim)

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1) Tractor	MF-185	MF-185	Ford-5000	MF-165
2) Attachment	Disc plough (26' x 4)	MF-24 (Chisel)	Off-set disc (22' x 9 x 9)	Leveler (1.5 m)

3) Testing

Soil condition	Test No.	Distance (m)	Time (sec)	Depth (cm)	Distance (m)	Time (sec)	Depth (cm)	Distance (m)	Time (sec)	Depth (cm)	Distance (m)	Time (sec)
A	1	150	54.5	15	150	60.0	20	150	62.3	15	150	64.5
A	2	150	51.2	15	150	64.5	20	150	53.5	15	150	57.6
A	3	150	64.3	20	-	-	-	150	-	-	150	-
A	4	150	57.5	20	-	-	-	150	-	-	150	-
B	5	150	70.5	15	150	64.0	15	150	64.3	15	150	64.2
B	6	150	80.0	15	150	67.3	15	150	57.3	15	150	58.5
B	7	150	73.0	15	-	-	-	150	55.0/1	15	150	53.5/2
B	8	150	80.0	15	-	-	-	150	51.3/1	15	150	49.0/2
C	9	100	not effective		100	not effective		100	not effective		-	-
C	10	100	not effective		100	not effective		100	not effective		-	-
C	11	-	-	-	-	-	-	-	-	-	-	-
C	12	-	-	-	-	-	-	-	-	-	-	-

Cone resistance and water ratio in the surface soil larger is estimated by the soil test and corne test with similar soil conditions in the Project area.

A ; Soft clay, empty weeds (4 kg/cm^2, 45 %)

B ; Moderate (5 k/cm^2, 30 %)

C ; Heavy hard weedy clay with crack (8 kg/cm^2, 18 %)

/1 2nd harrowing (3.5 kg/cm^2 after first harrowing)

/2 After 2nd harrowing (3 kg/cm^2)

Table 13.3 Workable Days

Condition of Estimate	Grade			
1) Daily rainfall (mm)	- 10	10 - 15	16 - 30	31 -
2) Rainfall hour	0	0.1	0.1	0.3

Estimation of Workable Days

1) Rainfall (Frequency/Month)

Daily rainfall	J	F	M	A	M	J	J	A	S	D	N	D	Total
10 - 15	0	0	0	0	0	0	2	3	0	0	0	0	5
16 - 30	0	0	0	0	0	0	1	1	1	0	0	0	3
30 -	0	0	0	0	0	0	1	1	0	0	0	0	2
Total	0	0	0	0	0	0	4	5	1	0	0	0	10
2) Rainfall hour	0	0	0	0	0	0	0.6	0.7	0.1	0	0	0	1.4
3) Warkable days/month	26	24	26	25	26	25	(23)/1	(22)/1	(24)/1	26	25	26	298
4) Total working hours/month	312	288	312	300	312	300	276	264	(144)/2	312	300	312	3,576

Note: /1; Figures in parenthese are excluded not only holiday but also 50% of rainy days estimated in the above.

/2; Figure in parentheses is estimated by 6 hr in working time/day because of Remandon.

Table 13.4 Farm Machinery Requirement for One Operation Unit (400 ha)

Operation	Type of Equipment	Working Capacity (ha/hr)	Capacity (ha/day)	Duration of Operation (days)	Workable Days (days)	Covering Area (ha)	Required Number of Equipment	Hauling Equipment
1) Plowing	Chisel plow	0.5	6	45	37	222	2	Tractor 75 ps class
2) 1st Harrowing	Disc harrow	0.9	11	45	37	407	1	"
3) 2nd Harrowing	Disc harrow	1.0	12	45	37	444	1	"
4) Basic Fertilizing	Broad caster	1.5	18	45	37	666	1	"
5) Rotavating	Rotavater	0.3	3.6	45	37	133	3	"
6) Ridging	Ridger	5.8	70	10	6/2	420	1	"
7) Final Levelling	Grader	1.2	14	45	37	518	1	Crawler 60 ps class
8) Seeding	Drill seeder	1.0	12	45	37	444	1	Tractor 75 ps class
9) Weeding	Power duster	4.2	50	45	8/3	400	1	Self propelled
10) 2nd Fertilizing	Power duster	4.2	50	45	8/3	400	1	"
11) 1st Pest Control	Power duster	4.2	50	45	8/3	400	1	"
12) 3rd Fertilizing	Power duster	4.2	50	45	8/3	400	1	"
13) 2nd Pest Control	Power duster	4.2	50	45	8/3	400	1	"
14) 4th Fertilizing	Power duster	4.2	50	45	8/3	400	1	"
15) Harvesting	Combine harvester	0.92	11	45	37	407	1	"
16) Flail Mower		1.08	13	35	31	403	1	Tractor 40 ps class
17) Paddy transportation	Dump truck (4 ton)	0.5	6	45	37	222	2	Self propelled
18) Straw transportation	Dump trailer (5 ton)	0.9	11	45	37	407	1	Tractor 75 ps class

/1 Estimated based on Table 13.3
/2 Ridging, straw cutting and collecting are undertaken by same tractor
/3 One operation requires net 8 days each

Table 13.5 Farm Machinery Selected and Their Numbers Required (Altanative I)

Machinery & Equipment	Type	Numbers: One operation unit (240 ha)	Numbers: Whole area (15,600 ha) /1
1) Tractor			
Wheel tractor	75 ps class	4	280
Crawler tractor	60 ps class	-	25
2) Combine harvester	100 ps class	1	70
3) *Equipment & Attachments*			
Chisel plough	7 to 9 shanks	1	70
Disc harrow	24" x 9 x 9	1	70
Broadcaster	400 ℓ	1	70
Rotavator	2.0 m	2	140
Ridger	1 row	1	70
Grader	3.0 m	1	70
Drill seeder	5.0 m	1	70
Power duster	360 ℓ, 40 m in length	2	135
Sprayer	*Knapsack type, B1*	2	140
Rear mounted mower	2.4 m	1	70
Side delivery rake	2.2 m	1	70
Dump trailer	5 ton	1	70
Dozer blade /2	2.5 m	-	23
4) Dump truck	4 ton	2	
5) Spar parts	-	L.S.	L.S.

/1 These number include some standby units

/2 To be attached to crawler type tractor

Table 13.6 Farm Machinery Selected and Their Numbers Required(Alternative II)

Machinery & Equipment	Type	Numbers: One operation unit (400 ha)	Numbers: Whole area (15,600 ha) /1
1) Tractor			
Wheel tractor	75 ps class	5	210
Crawler tractor	60 ps class	-	25
2) Combine harvester	100 class cutting width, 4.5m 3,500 ℓ of grain trank semi crawler type	1	43
3) Equipment & Attachments			
Chisel plough	7 to 9 shanks	2	90
Disc harrow	24" x 9 x 9	2	90
Broadcaster	400 ℓ	1	44
Rotavator	2.0 m	3	129
Ridger	1 row	1	42
Grader	3.0 m	1	42
Drill seeder	5.0 m	1	42
Power duster	360 ℓ. 40 m in length	2	90
Sprayer	knapsack type, 13ℓ	3	130
Rear mounted mower	2.4 m	1	43
Side delivery rake	2.2 m	1	43
Dump trailer	5 ton	1	43
Dozer blade /2	2.5 m	-	25
4) Dump truck	4 ton	2	85
5) Spare parts	-	L.S.	L.S.

/1 These number include some standby units.

/2 To be attached to crawler type tractor.

Table 13.7 Farm Machinery Selected and Their Number Required (Alternative III)

Machinery & Equipment	Type	Numbers: One operation unit (485 ha)	Numbers: Whole area[/1] (15,600 ha)
1) Tractor			
Wheel tractor	75 ps class	8	280
Crawler tractor	60 ps class	-	25
2) Combine harvester	100 ps class	1	35
3) Equipment & Attachments:			
Chisel plough	7 to 9 shanks	1	35
Disk harrow	24" x 9 x 9	1	35
Broad caster	400 ℓ	1	35
Rotavator	2.0 m	2	70
Ridger	1 row	1	35
Grader	3.0 m	1	35
Drill seeder	5.0 m	1	35
Power duster	360 ℓ, 40 m in length	3	110
Sprayer	Knapsack type, 13 ℓ	4	150
Rear mounted mower	2.4 ℓ	1	35
Side delivery rake	2.2 m	1	35
Pump trailer	5 ton	1	35
Dozer blade[/2]	2.5 m	-	23
4) Dump track	4 ton	2	70
5) Spare parts	-	L.S.	L.S.

/1 These number include some standby units

/2 To be attached to crawler type tractor

Table 13.8 Comparison of Alternatives on Farm Mechanization

Alternatives	Cropping Pattern	Sowing or Harvesting Period	Basic Net Working Hour	Req.No.of Wheel Tractor	Covered Area per Group /1	Initial Investment Cost/ha	Operation & Maintenance Cost/ha
		(month)	(hr)	(unit)	(ha)	(LS)	(LS)
I.	Double	1.0	12.0	4	240	369	127
II.	Double	1.5	12.0	5	400	257	94
III.	Double	2.0	12.0	8	485	253	95

/1 The area of each group is decided to be covered by one combine harvester.

Table 13.9 Fuel Consumption (Machinery Operation for 400ha)

1. Wheel Tractor:

   6,150hr/year x 9 ℓ/hr x 0.5 l.f. = 27,675 ℓ/year

2. Power Duster:

   1,300hr/year x 2.5 ℓ/hr x 1.0 l.f./1 = 3,250 ℓ/year

3. Combine Harvester:

   1,000hr/year x 15 ℓ/hr x 0.75 l.f./1 = 11,250 ℓ/year

4. Damp Truck:

   20,000 km /year ÷ 8km/ℓ = 2,500 ℓ/year

5. Knapsack Sprayer:

   100hr/year x 0.5 ℓ/hr x 1.0 l.f./1 = 50 ℓ/year

Total	44,725 ℓ/year (say 44,800 ℓ/year)

Note: /1 l.f. means load factor

Peak fuel consumption is at the harvesting of grain and soil preparation works. It will be about 15,000 liters per work season.

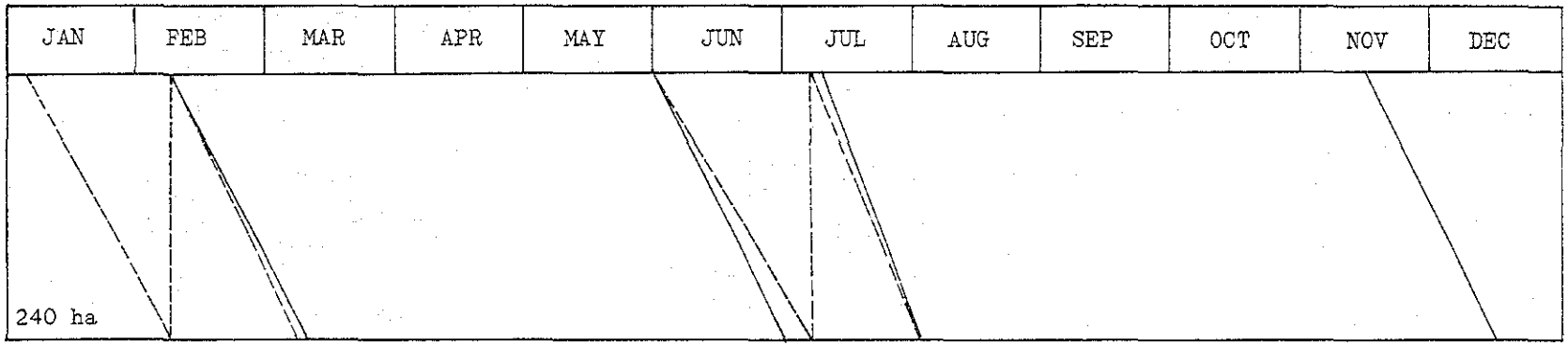
Table 13.10 Required Number of Operator, Operator Assistant and Laborers (Alternative II)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
1. Tractor operator	5	5	4	-	-	3	5	5	-	-	-	5	32
2. Tractor operator assistant	10	10	8	-	-	6	10	10	-	-	-	10	64
3. Harvester operator	1	-	-	-	-	1	1	-	-	-	1	1	5
4. Harvester assistant	2	-	-	-	-	2	2	-	-	-	2	2	10
5. Truck driver	2	1	1	1	1	2	2	1	1	1	2	2	17
6. Truck driver assistant	2	1	1	1	1	2	2	1	1	1	2	2	17
; Operator	8	6	9	1	1	7	8	6	1	1	3	8	59
Assistant	14	11	5	1	1	14	14	11	1	1	4	14	91
Total	22	17	14	2	2	21	22	17	2	2	7	22	150
7. Laborer, permanent	4	4	4	4	4	4	4	4	4	4	4	4	48
seasonal	4	-	-	-	-	4	4	-	-	-	4	4	20

Table 13.11 Outline of Workshop

Facilities & Equipment	Quantity	
	Central workshop	Branch workshop (per one unit)
1) Building		
Workshop	450 m^2	120 m^2
Shade roof	1,000 m^2	1,000 m^2
2) Workshop equipment		
Generating sets (kVA 145)	2 Nos.	1 Nos.
Lathe (medium type)	1 "	-
Welding units (Gas & Arc)	2 "	-
Welding sets (300A)	2 "	-
Grinding machine (205ϕ, 150ϕ, 100ϕ)	2 "	-
Drilling machine (6.5ϕ, 10ϕ, 20ϕ)	2 "	-
Air compressor (2.2 kW)	1 "	1 Nos.
Battery charger (quick type)	1 "	1 "
Injector test unit (200 kg/cm^2) 6 cylinder	1 "	1 "
Tyre repair kit	1 Set	1 Set
HYD press (35 ton)	1 Nos.	-
Blacksmith equipment	1 Set	1 Set
Tool kits	12 "	4 "
Miscellaneous equipment	L.S	L.S
Grease & lub. equip.	L.S	L.S
3) Vehicles		
Service car	3 Nos.	-
Fuel tanker (700 gal)	1 "	1 Nos.
Lorries (6 ton)	1 "	-
4-wheel drive	1 "	1 Nos.

Fig. 13.1 Cropping Pattern of Major Farm Machinery Operation (Alternative I)



Ploughing	wheel tractor 1	wheel tractor 1
Harrowing	wheel tractor 1	wheel tractor 1
Ridging & Levelling	wheel tractor 1	wheel tractor 1
	(crawler tractor 1)	(crawler tractor 1)
Broadcasting	wheel tractor 1	wheel tractor 1
Rotary Tilling	wheel tractor 2	wheel tractor 2
Sowing	wheel tractor 1	wheel tractor 1
Harvesting	combine harvester 1	combine harvester 1
Straw Cutting		
Straw Collecting		
Straw Transporting		

Fig. 13.2 Cropping Pattern of Major Farm Machinery Operation (Alternative II)

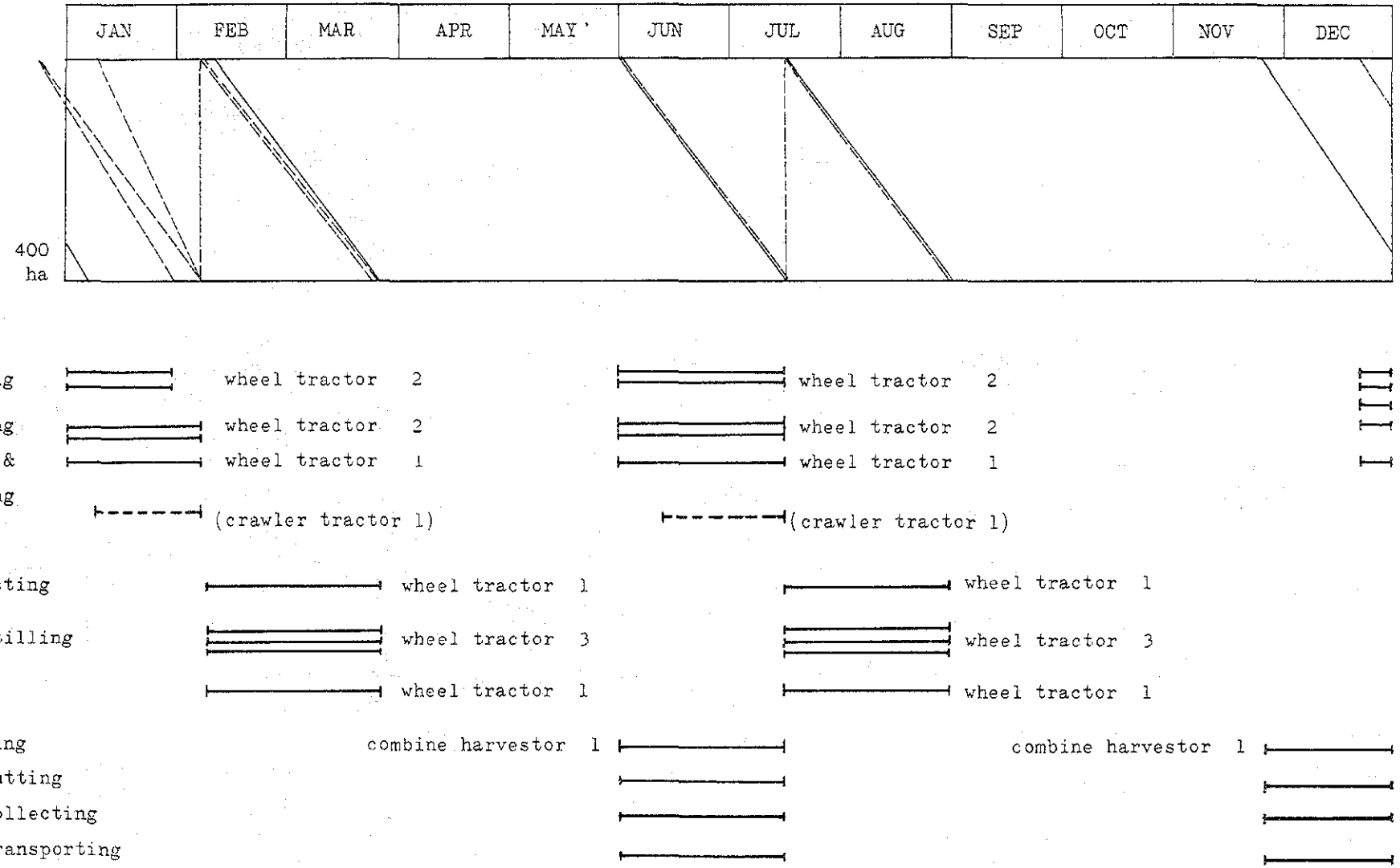
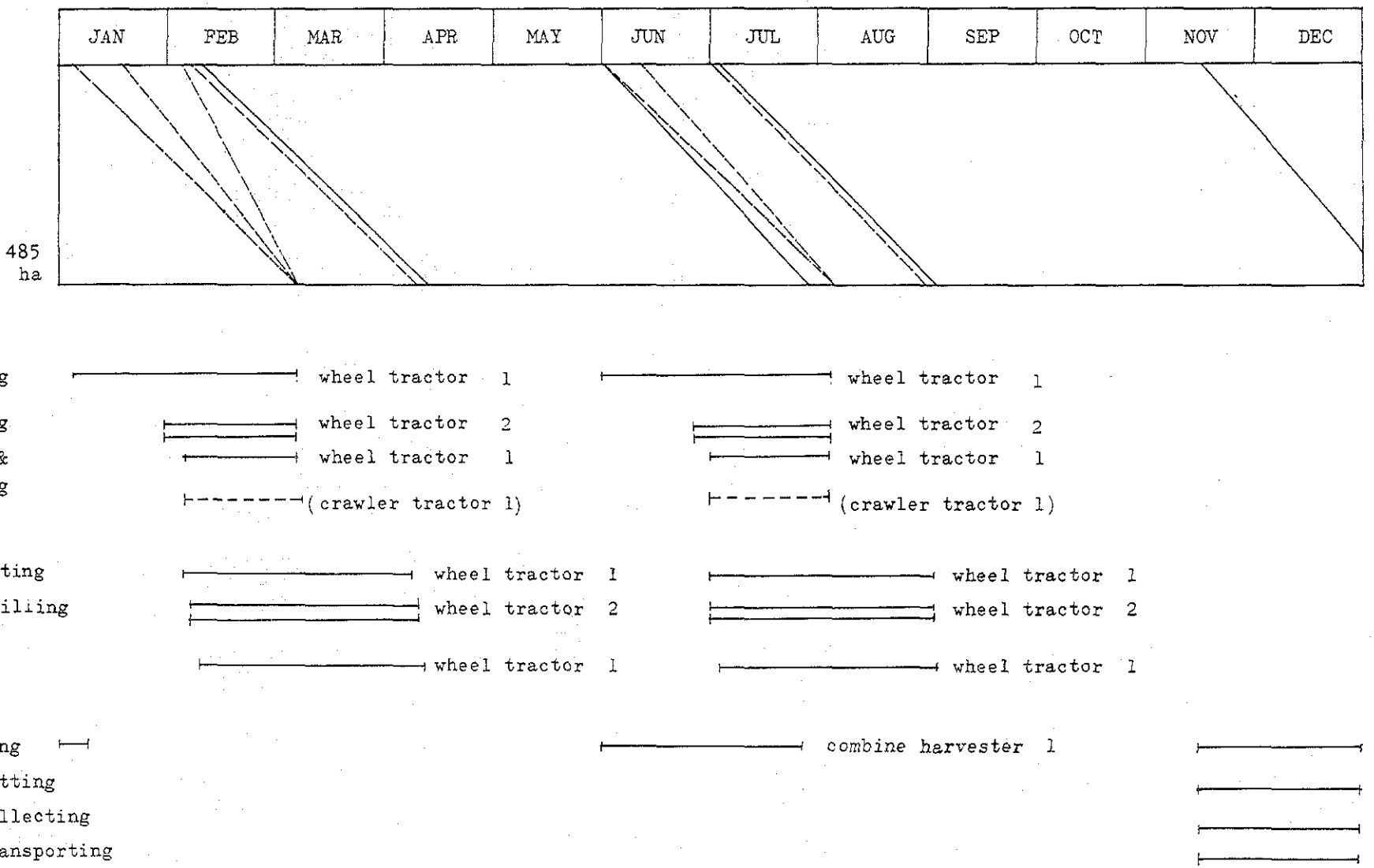


Fig. 13.3 Cropping Pattern of Major Farm Machinery Operation (Alternative III)



ANNEX XIV

RICE PROCESSING

ANNEX XIV

RICE PROCESSING

XIV. RICE PROCESSING

14.1 General

Upon completion of the project, about 156,000 tons of paddy will be produced a year. It is essential for the project to equip with effective rice mill and storage facilities to keep high quality and marketing them on favourable conditions.

According to the development programme of the project and the anticipated quantity of production shown in Table 14.1, the total capacity of mill will be 93,600 tons a season in the whole project. The rice mill proposed herein will be installed in five places in the project area in parallel with the stage-wise development programme. Each rice mills will have same processing capacity and capable processing system for the quantity to be produced, taking into account the operational conditions anticipated in the project, and also to keep high quality of rice.

14.2 Processing System

There are several different processing systems which are commonly used in modern rice mills. The proposed system to be acceptable in the project is as follows.

1) Receiving Section; to receive and to clean the grains
2) Storing and Drying Section; to store and to control the grain moisture
3) Parboiling Section; to parboil the grain
4) Milling Section; to mill the parboiled grain into quality white rice

The process of parboiling is indispensable in this processing programme due to the following reasons;

1) The rice produced by the project will be planned to export to the oil producing countries nearby where the people have high familiality with the parboiled rice.

2) The grains produced in the project area will be foreseeable to crack or sun-check because of over drying, due to low relative humidity and then those will be broken under processing without parboiling.

To operate the major equipment at high efficiency, storage is equipped between the receiving and parboiling sections. Outline of the processing system is explained in 14.3 and the details are shown in the list of equipment in 14.5.

14.3 Outline of Rice Processing

14.3.1 Receiving and Cleaning

The grains harvested are transported to the rice mill by truck and weighed on a truck scale, then conveyed to the grain cleaner through the feeding hopper and bucket elevator.

In the cleaning sections any foreign materials and impurities will be eliminated from the grains.

The grain cleaner(s) is equipped with (a) scalping reel which will take out larger foreign matters (b) aspirator which will suck out dust and lighter particles; and (c) oscillate sieve which will eliminate remaining impurities and sand.

14.3.2 Storage

The facility is composed of 12 flat-bottom, corrugated-wall, round bins arranged in two straight rows.

Each storage bin is equipped with aeration device which consists of ventilator on the top, air-inlet at the wall foot, air ducts and a stationary fan. If moisture content of grains is over than 15%, the aeration will be practiced to reduce moisture to safely storable level at 15%.

14.3.3 Parboiling

The grains will be delivered to this section from the storage bins in general, while during the harvesting time, grains will be fed directly

into this section after passed the cleaning section.

In the parboiling process, the grains will be put into parboiling bins and will soak (steep) by about 70°C hot water for 3 to 3.5 hours. The hot water will be prepared by the use of water-steam supplied from a boiler which will be stoked by the use of paddy husk furnace. After the grain soaking, the hot-water will be drained out, and thereafter, cooking will be practised by use of steam. The steaming will be continued for around 10 minutes with 5 to 7 kg/cm^2 in pressure.

The parboiled grains usually have about 35% w.b. moisture content. Thus, these grains will be dried by the use of horizontally installed drum type rotary dryer(s), and the moisture content of grains will be reduced to around 25% w.b. by this practice.

Following the drying process, the grains will be fed into tempering bins and will be tempered for several hours for uniforming the moisture distribution in the grain.

After tempering, grains will be passed through columnar dryer (heated-air drying type) and back again to the tempering bins for tempering. During one passing the drying process, moisture of the grain is reduced by the rate at 2% on an average. Thus this practice will be repeated 4 to 5 times until the moisture contents to be attained to 15% in moisture level.

Parboiled and dried grain will be temporarily stored in mill-day-bin(s) and then drawn to milling section.

14.3.4 Milling

Milling section consists of three parallel lines equipped with grain cleaners having the function and construction as same as those in receiving section, grain from mill-day-bins will be cleaned again before milling and then fed to dehuller.

Grain dehuller consists of rubber-roller, dehulling head and a husk aspirator. After dehulling, brown rice will be descend into the following aspirator. In the aspirator brown rice and husk will be

separated effectively. Husks will be pneumatically transported to the boiler room and will be used for fuel. (It will be expected that the quantity of husks will be sufficient for parboiling the rice.) The brown rice and the rice unhusked at the first dehulling will be conveyed to the grain separator. Paddy separator(s) is of multi-layer separating trays with numerous dimples inclined in longitudinal and latitudinal directions.

Those brown rice mixed with unhusked grains will be separated into three classes, i.e. (1) unhusked grains, (2) brown rice and (3) unhusked grains mixed with brown rice.

1) Unhusked grains will be returned to the dehuller,

2) Brown rice will be conveyed to the whitening machine,

3) Mixture of brown rice and unhusked grain will be returned again to the separator.

Whitening process will be consist of 4 stages in a series. The first 3 processing will be made by the abrasive type whitening machine, and the last processing will be by friction type whitener. Each abrasive type machine incorporates abrasive roller made by carborundum, and surrounded, with perforated steel cylinder. Brown rice is fed into the first machine and passes through the roller and the cylinder, where bran layer of grain will be scrapped and cut by sharp edges of the roller under least pressure without damages. Besides, air blow-device incorporated in the machine which accelerates to discharge the bran and also prevents the bran from adhering to the cylinder.

Friction type machine incorporates milling roller surrounded with perforated screeen and air-flow-device. While passing through the roller and the screen, rice grain is rubbed with each other in the whitening chamber.

Refining machine consists of vertically-installed, conical-shaped rotating refining-drum with numerous leather strips; and surrounded with the wire-meshed screen. While passing through the drum and screen, the rice grain will be polished into white rice at pearly appearance.

Bran produced during whitening is pneumatically sucked out by fans and collected through cyclone-collectors.

Rotary sieve consists of multi-layer with wire-meshed flat sieves with gratory movement. Through this sieve, fine broken rice will be separately collected into the container attached to this unit.

Length grader consists of 3 rotating cylinders with numerous indents. The whitened rice will be classified into 2 classes by the first 2 cylinders namely (1) whole rice and (2) mixture of large and smaller broken rice. The latter class will be furthermore classified into large and small broken in category by the last cylinder.

Whitened rice in each category will be stored in the bins. These finished product will be automatically weighed and packed into bag. The bag will be stitched by bag-stitcher nearby. Packed product will be then, stored in the ware house or directly send to the market.

14.4 Capacity of the Plant

The processing capacity of the plant proposed herein is estimated based on the following assumptions.

14.4.1 Basic Design Condition

(1) Operational condition

a) Cropping pattern: Double cropping per annum

b) Seasonal processing amount(by second cropping):

15,600 ha x 6 t/ha ÷ 5 plants = 19,000 tons of unhusked grain per plant

c) Working condition

Sections of the mill	Working Conditions	
	Daily (hour)	Seasonal (day)
Receiving	12	37
Parboiling	24	150
Milling	24	150

(2) Atmospheric condition (Harvesting season)

a) Temperature (mean): Max 39.6°C
Min 17.2°C

b) Relative humidity (mean): Max 49 %
Min 24 %

(3) Condition of grains to be processed

a) Moisture content of receiving paddy: 14 - 19 % w.b.

b) Apparent density of grains

Unhusked grain: 0.6
Brown rice and white rice: 0.8

c) Variety of rice

High yielding varieties produced in the Project

d) Milling efficiency

Husk/Brown rice:	20 - 22 %
Bran/Brown rice:	9 - 10 %
Foreign matters at receiving section:	1 % or below

14.4.2 Capacity of the Plant

Based on the design conditions stated in the above and the delivery quantity from the field estimated in ANNEX XII, required capacity in each section of the proposed mill is estimated as follows:

(1) Receiving and cleaning section

Assuming that for estimation of the receiving capacity of the mill, the maximum yield of 6 ton/ha by the second crop is taken into account.

15,600 ha x 6 ton/ha ÷ 5 unit plant = 19,000 ton per plant
19,000 ton ÷ 12 hr/day ÷ 37 days = 43 ton/hr per unit plant

Receiving quantity of rice will be 43 ton/hr per unit plant as the capacity by constant operation. In due consideration of probable peak operation at the harvesting time, 80 tons/hr in receiving capacity is estimated in this processing programme.

(2) Storage Section

In comparison with the receiving quantity and milling capacity, the required storage capacity is calculated as follows:

Total quantity of farm production to be received by unit plant during the harvesting time is 19,000 tons.

Total quantity of production can be processed during the harvesting time is 5,300 tons.

19,000 tons - 5,300 tons = 13,700 tons say 14,000 tons

The storage capacity to be required is about 14,000 tons per season. Some 12 % of capacity allowance is provided in this estimation in due consideration of the probable happening caused by the mechanical troubles on the processing lines.

14,000 ton x 1.12 = 16,000

Thus, maximum capacity to be required for grain storing will be 16,000 tons in a season.

(3) Parboiling Section

About 19,000 tons of productions will be processed within 6 months (150 days in net) after the harvesting because of the production to be newly harvested in next cropping. Therefore, the quantity to be processed a day is estimated about 127 tons. Some 12 % of capacity allowance is also assumed, and then, estimated parboiling capacity will be 144 ton per day.

(4) Milling Section

About 127 tons (say 130 tons) of parboiled grain will be conveyed daily to the milling section. To receive this quantity, the mill-day-bins will be 140 tons in capacity inclusive of some capacity allowances.

The maximum milling capacity is estimated based on the 19,000 tons in maximum quantity to be processed for 150 days in net working duration and 24 hours per day by three shift operation. The milling capacity required to be processed a day is, then, 127 tons and/or 6 tons per hour.

Three units of milling machine having 2-ton capacity in each are proposed to install in three lines, for covering 6 tons per hour in the total milling capacity. This size of milling machine (2-ton type) is generally accepted from the viewpoint of not only economical operation but also small building space required compare with installing other large or small types.

Mechanical troubles of milling lines are unavoidable. However, the losses caused by probable troubles will be sufficiently compensated in the allowances of capacity provided on each parboiling section, storage section and mill-day-bins.

(5) Power Supply Station

All of the machinery in the plant will be driven individually by electric motors. Electricity required to operate the machinery and lighting the plant building and yard will be 1,000 KW (415 V/240 V, 3 ϕ/4W), and it will be supplied from the power generating station equipped with engine-driven-generators. Five units of 250 KVA generator with 300 ps diesel engine will be installed in each unit plant, including one unit of stand by.

(6) Fuel Tank

According to the operation schedule stated in the above, the mill will be operated for 150 days continuously in each crop season. Thus the daily fuel consumption is estimated at the amount of 6,400 ℓ in total (see 14.7.1).

To ensure the high milling quality of rice and prevent wastage of productions smooth operation of the mill is essential, and most interruption on the operation is caused by the troubles of fuel supply. Thus the storage tank for fuel supply is assumed by 80,000 ℓ, in stock capacity which will be equivalent to the requirement for 10 days operation with some allowances.

For easy and safe operation of the fuel storage, it is recommended to install 4 tanks, separately, with 20,000 ℓ capacity in each tanks. The tank capacity will be economical size for transportation and installation works.

14.5 Machinery and Equipment

Machinery and equipment required for the rice mill plant are listed in the following table.

List of Machinery and Equipment

Description	Quantity
1. Receiving and Cleaning Section(80 t/h)	(set)
- Truck scale (20tons)	1
- Receiving hopper	4
- Grain Cleaner Comprising scalping reel, aspirator and oscillating sieve capacity(20 tons/hr each)	4
- Conveying equipment Bucket Elevators, Screw Conveyors, Belt Conveyors, etc.	1
- Other miscellaneous equipment and materials required	1
2. Grain Storage Section (18,000 ton)	
- Storage bin (1,500 ton/each) All steel construction, flat bottom, corrugated wall, round bin, complete with aeration equipment for drying paddy and sweep unloader	12
- Conveying equipment Bucket Elevators, Screw Conveyors, Belt Conveyors, etc.	1
- Other miscellaneous equipment and materials required	1
3. Parboiling Section (144 tons/day)	
- Parboiling bin (9 ton/each)	4

- to be continued-

All steel construction, hoppered bottom bin, complete with steam and water pipings, structural supports, and discharge valve	
- Rotary dryer Horizontally installed, rotating drum type dryer	2
- Tempering bin (24 ton/each) All steel construction, hoppered bottom bin, complete with aeration equipment	8
- Columnar dryer Continuous flow, forced heated-air dryer, complete with furnace, fan, ductings, and fuel service tank	2
- Boiler Equivalent evaporation: 3000 kg/hr Water softening device	1
- Conveying equipment Bucket Elevators, Screw Conveyors, Belt Conveyors, etc.	1
- Other miscellaneous equipment and materials required	1

4. Milling Section (2 tons/hr x 3)

- Mill-day-bin (70 ton/each) All steel construction, hoppered bottom bin	3
- Rice Cleaner Comprising scalping reel, aspirator and oscillating sieve, capacity (2 tons/hr)	3

- to be continued -

- Destoner	3
Comprising aspirator and Oscillating sieve capacity (2 tons/hr)	
- Grain Husker	3
Comprising rubber roller type Husker head and closed-circuit type husk aspirator capacity (2 tons/hr)	
- Grain Separator	3
Comprising dimpled oscillating trays capacity (2 tons/hr)	
- Whitening Machines	3
Three abrasive type whiteners and one friction type whitener capacity (2 tons/hr)	
- Refining Machine	3
comprising vertical refining drum with leather-strips capacity (2 tons/hr)	
- Rotary Sieve	3
Comprising multi-layer flat sieves with gyratory movement capacity (2 tons/hr)	
- Length Grader	3
Comprising three indented cylinders capacity (2 tons/hr)	
- Scale Shutter	3
Comprising auto-gate electrically combined with platform scale	
- Bag Sewing Machine	3
Conveying equipment	1
Bucket Elevators, Screw Conveyors, Belt Conveyors, etc.	

- to be continued -

- Other miscellaneous equipment and materials	1 lot
5. White rice storage capacity: 2,200 ton (equivalent to 2-week processing amount)	
6. Control panel and wiring materials	2
7. Power Station	5
- Diesel-engine generator (300 p.s/unit) capacity (250 kVA/unit)	
- Fuel & oil tank & supply system capacity (20,000 ℓ/tank)	4
8. Spare parts	L.S.

14.6 Operation Organization

To successfully operate and manage the proposed rice mill, the following sections will be organized in each plant under the Department of Processing in the Project Organization as stated in Annex XV.

(1) Administration section

The section will be staffed with one plant manager and foreman (assistant manager) who have a responsibility on all the operation and management of the mill, and coordinate with other mills for controlling the constant milling operation as a whole. Under the section, five operation and maintenance sections will be organized, according to the functions in each unit of the mill.

(2) Operation and Maintenance Sections

2)-1 Reciving and cleaning section

This section will be staffed with one operator and three regular

labourers, and these staff will be supported by the seasonal or temporally employed labourers. The operator will coordinate between harvesting section under the Department of Agricultural Production and other operation and maintenance sections in the mill through the function of the administration section (plant manager). To check the qualities of production in each farm plot and to inform those to the field are one of the important work in this section.

2)-2 Drying and storage section

This section will be staffed with one operator and three regular labourers, and at the peak time, the works will be supported by seasonal employees. The operator has a responsibility particularly on the grain moisture control and storage control.

2)-3 Per-boiling section

The section will be require to staff at least one operator and three assistant operators because of 24-hour operation by 3-shift a day. In each work shift, two regular labourers will be staffed as the boiler-man.

2)-4 Milling section

The section will also continuously operate in a full day and full season by three work shift a day. Thus it will be staffed, at least, with one operator and three assistant operators and five labourers for one work shift. The operator has a responsibility particularly on the quality control of milled rice.

2)-5 Maintenance section

This section will be staffed with one mechanical engineer, three mechanics and three regular labourers. These staff will make repair and maintenance services for each operation section by the three work shift a day. This section will also be responsible to operate the power station.

The operation organization is summaried in the following Fig.14.1.

14.7 Operation and Maintenance of Rice Mill

14.7.1 Fuel Consumption

As presented in the previous Chapter, all of the machinery will be driven by electric motors, and the electricity required will be generated in the power station individually installed nearby the unit mill plant. For the generator operation, an annual requirement of the fuel is estimated on the basis of the following conditions:

Fuel consumption of one unit generator	67 ℓ/hr
No. of generator to be operate regularly	4 Nos.
Operation hour a day	24 hrs.
Operation duration a year	250 days
Load factor for operation period	0.60

67 ℓ/hr x 4 Nos x 24 hr/day x 250 days/year x 0.60
= 964,800 ℓ/year (say 1,000,000 ℓ/year)

Thus, the annual requirement of fuel for power generation is about 1,000,000 liters.

As for the drying of par-boiled grains, two rotary dryers and two columnar dryers will be fully operated in a milling season. For this operation, fuel oil is also required as follows:

30 ℓ/hr/dryer x 4 Nos. x 20 hr/day = 2,400 liters/day

2,400 ℓ/day x 250 days/year = 600,000 liters/year

From the fuel oil consumption on both power generating and drying of grains, the total requirement of fuel oil is estimated about 1,600 kilo-liters a year.

14.7.2 Materials

The materials required in the mill operation are the sack for packing the milled rice. Say 100 kg in capacity will be applicable for the purpose of transportation and storing. To use of these sacks, such sewing string as consumables are also indispensable. The numbers

of sack required are estimated about 221,000 a year.

14.7.3 Repair and Maintenance

To successfully operate the rice mill and also to ensure the high quality of milled rice, daily maintenance and periodic repair and maintenance services are indispensable. As for the daily maintenance, the maintenance section organized in each unit plant will have a responsible and the services will be carefully made on each machinery and equipment. While, the periodic services will be made by the staff in the work-shop proposed in Annex XIII.

In the periodic services, the following parts or unit will be regularly exchanged:

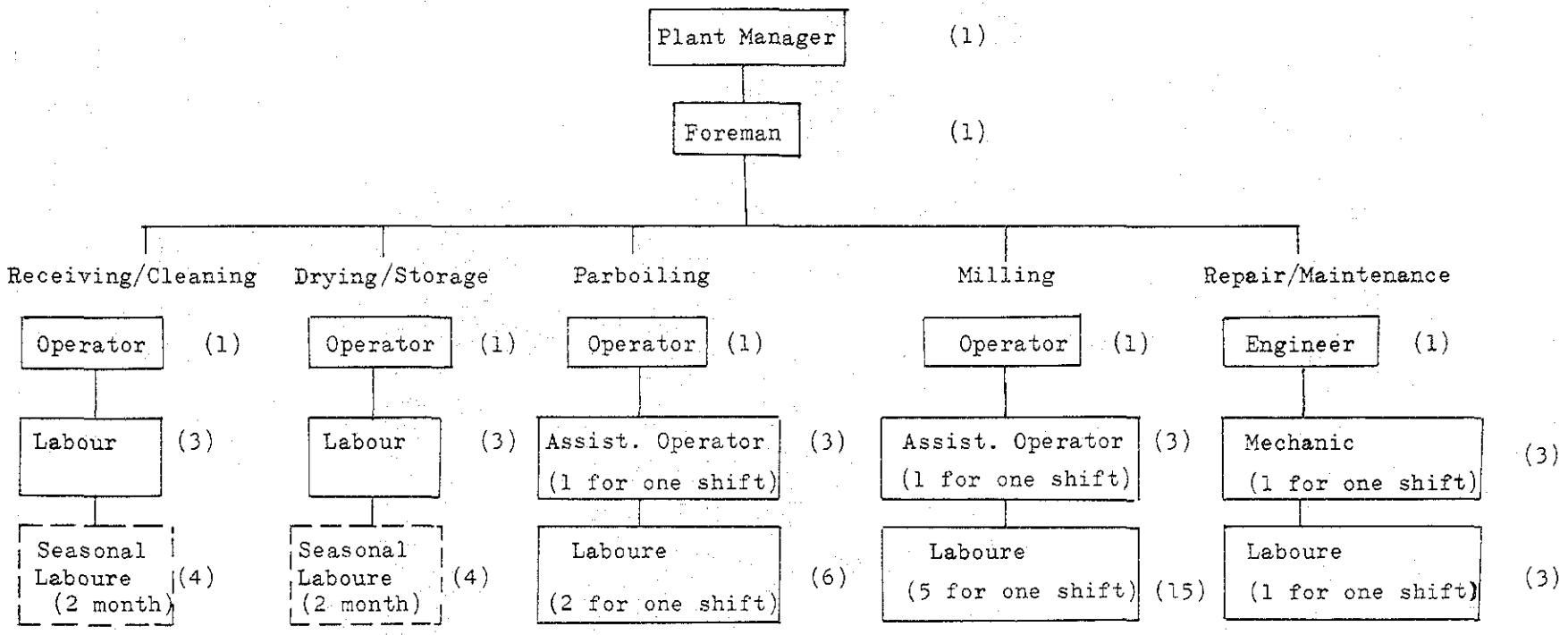
- Abrasive type whitener and friction type whitener; after the works with about 9,000 tons of grain
- Milling roller; after the works with about 8,000 tons of grain
- Screen; after the works with about 5,000 tons of grain
- Rubber roller; after the works with about 50 to 100 tons of grain
- Screw iron roller; after the works with about 15,000 tons of grain
- The other parts and/or unit will be also maintained carefully and periodically changed in dependence with the useful life or certain degree of defacement defined in the specifications.

Table 14.1 Quantity of Production

Phase	Tract	Planted Area (ha)	Harvested Paddy		
			1st Crop (ton)	2nd Crop (ton)	Total (ton)
1	I	3,000	12,000	18,000	30,000
2	II-1/1	3,200	12,800	19,200	32,000
3	II-2/1	3,200	12,800	19,200	32,000
4	III	3,000	12,000	18,000	30,000
5	IV	3,200	12,800	19,200	32,000
Total		15,600	62,400	93,600	156,000

/1 : The project area of Tract 2 is divided into two stages according to the implementation schedule.

Fig 14.1 Operation Organization in Unit Plant and Staffing



	Receiving/Cleaning	Drying/Storage	Parboiling	Milling	Maintenance	Total
Shift(1)	4	4	4	7	3	22
Shift(2)	4	4	3	6	2	19
Shift(3)	0	0	3	6	2	11
Total	8	8	10	19	7	52

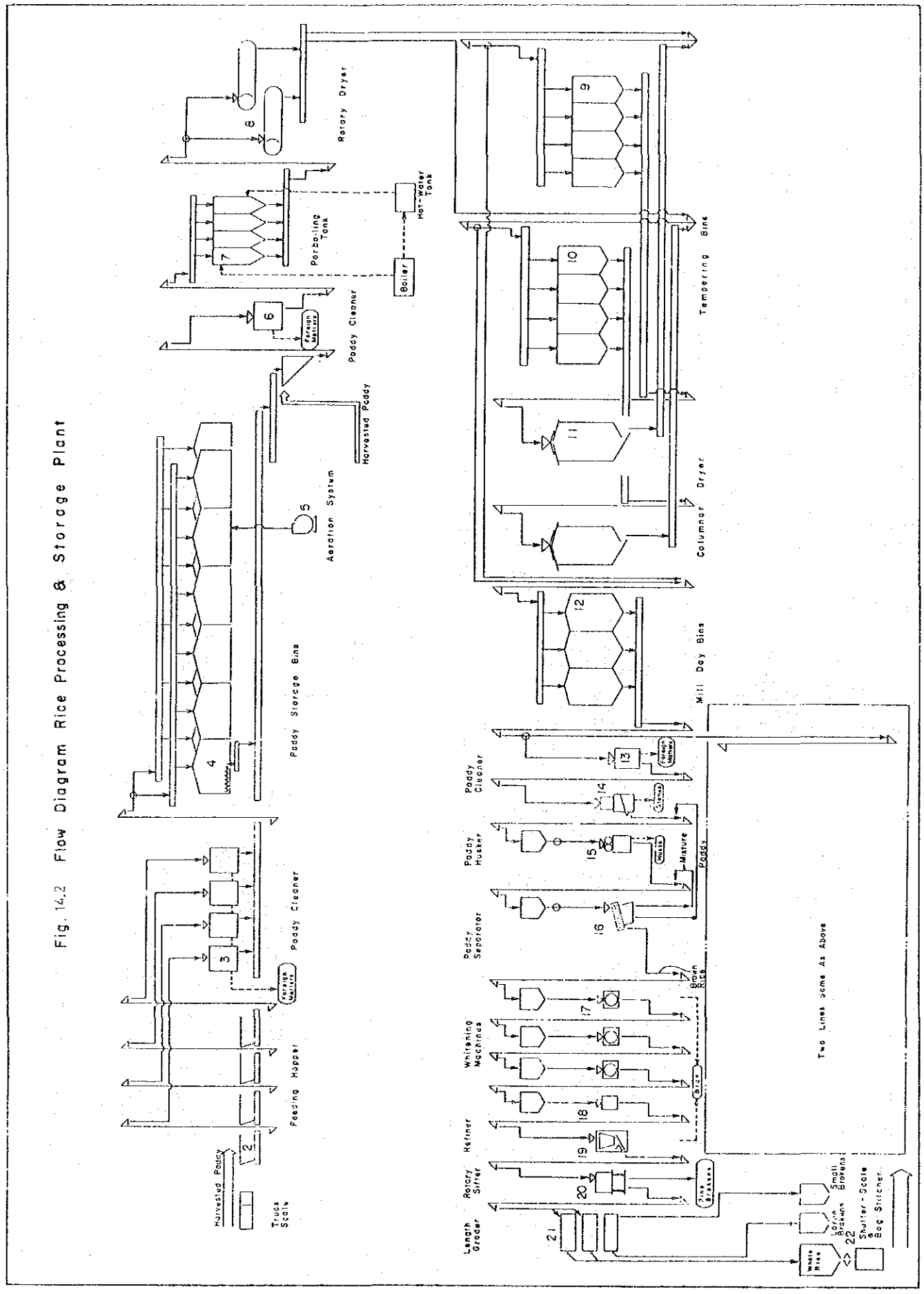


Fig. 14.2 Flow Diagram Rice Processing & Storage Plant

ANNEX XV

PROJECT ORGANIZATION AND MANAGEMENT

ANNEX XV

PROJECT ORGANIZATION AND MANAGEMENT

Tables

Figures

XV. PROJECT ORGANIZATION AND MANAGEMENT

15.1 Proposed Organization

For the construction and the management of the Gasaba Rice Production Project, an executing organization will be established under the guidance and the assistance by a project coordination committee which will constitute of the representatives from the concerned Ministries and Organizations i.e., Ministry of Agriculture, Food and Natural Resources, Ministry of Irrigation and HEE, Ministry of Finance, Planning and National Economy, Ministry of Commerce and Supply, Bank of Sudan, Agricultural Research Corporation and the local government of the White Province. The organization will be semi-autonomous type organization which will run by its our revenue.

Aiming at successful execution of the project, the most suitable system should be adopted for the operation and maintenance of the project, paying due attention to the present production and the institutional support systems for agriculture in the Sudan and the characteristics of the project.

At present, crops are cultivated under five kinds of production systems as follows.

i) Farmers produce crops using mainly family labor

ii) Public corporations manage the production of crops. Under the management, tenants are engaged in farming operations. In case of cotton, the tenants and the corporations share the produce. In case of the other crops, the tenants pay water charge to the corporations.

iii) Agricultural cooperatives produce crops

iv) Private pumping scheme owners produce crops using hired laborers.

v) Public corporations such as the Mechanized Farming Corporation produce crops using hired laborers.

The characteristics of the project and the institutional environment for agriculture in Sudan that are to be taken into consideration are as follows.

a) The history of rice production is very short and the present production level is very low./1 The farmers or tenants who have even the slightest knowledge of rice farming practice is very limited. It is rather difficult to find experienced technical staff and experts in rice production.

b) Institutional support systems for farmers and cooperatives is not yet adequate so far./2

c) The Gasaba Rice Project will be a big scale agricultural project. The net acreage will be 15,600 ha and expected production of paddy will be 156,000 tons.

d) Intensive and big scale mechanized farming will be practiced.

Farmers or tenants could produce rice under the management of the organization in the project area if they are provided with certain period of time for training for rice cropping and farm machinery operation. Either crop sharing system or water charge system could be adopted. In either case, the higher the production, the higher their return would be. They will have enough incentives for increasing the production.

The holding size have to be relatively small, ranging approximately between 2 to 10 ha. Intensive and large scale mechanization will, however, be adopted for the operation of the project. Unit field operation size will be 400 ha for the efficient operation of farm machinery. Farmers with small holdings cannot serve for this aim.

A cooperative could be considered for the operation and maintenance of the project. It could be divided into groups for the management of irrigation water and for the efficient operation of farm machineries. The cooperative can either share the produce with the executing organization or pay water charge to the organization. The higher the production level becomes, the bigger return the members of the cooperative would obtain. They will have enough incentives for raising the production.

/1: See 7.1.2 in Annex VII.
/2: See Annex VIII.

The existing cooperatives in the Sudan, however, possess several problems to solve./1 Further, the institutional support system for guiding and assisting the cooperatives is yet to be strengthened. The time has not come yet for cooperatives to run the Gasaba Project.

Private Pumping Scheme system can be adopted for the operation and maintenance of the project. In this case, however, the project would benefit only a small number of farmers, which is not desirable because of equity reason.

The Mechanized Farming Corporation which was established in 1968 by the Sudan Government manages and operates five state farms for the production of sorghum, cotton and sesame using hired laborers. The total cropping area of these five state farms amounted to about 168,000 ha in 1976. Each state farm is divided into field operation until with the area of about 630 ha. Intensive and large scale mechanized farming is practiced successfully in these farms.

We recommend that State Farm System be adopted for the successful execution of the project because of the following reasons.

i) Intensive and large scale mechanized farming is practiced through the system.

ii) Only one authority will be concerned with the whole production process which is expected to result in efficient management of the project and in easier control of production cost.

iii) It would be quite difficult to adopt the other production systems which are prevailing in the Sudan so far for this project which will be implemented in the near future.

We recommend that the operation and maintenance of the project be conducted by a or a group of agricultural cooperatives in future when the problems which the cooperatives possess at present are solved and the institutional support for them are strengthened adequately. It is likely that the change will bring higher level of the production of the project which will bring about the well-being of the project participants.

/1 See 8.2 in Annex VIII

15.2 Organization Structure of the Executing Organization

15.2.1 Organization

For the execution of the project, an executing organization will be established under the guidance and the assistance by the Project Coordination Committee. The executing organization or the Gasaba Project Office will be responsible for the construction of the project as well as the operation and maintenance of the project. The functions of the Project Office will be as follows.

i) Design and supervision of the construction of the irrigation and drainage facilities, road network and dike for the whole project area.

ii) Installation of the rice mills and the related facilities.

iii) Procurement of machineries and equipments required for the project.

iv) Operation and maintenance of the irrigation and drainage facilities, road network and dike.

v) Operation and maintenance of farm machineries and equipments.

vi) Operation and maintenance of the rice mills and related facilities.

vii) Operation and maintenance of the workshops and related facilities.

viii) Procurement of the farm inputs.

ix) Storage, processing and marketing of the products.

x) Accounting and administrative affairs.

For executing the project, the Gasaba Project Office will have four departments and two unit i.e., Department of Personnel and General Affairs, Department of Finance and Commercial Affairs, Department of Agricultural Production, Department of Engineering, Planning Unit and Advisory Unit under the management of the project manager. The organization chart of the executing organization is given in Fig. 15.1. The

details of the functions of the departments and the units are described in Table 15.1.

For the efficient management of the project area of 15,600 ha, the project area will be divided into five schemes with the average area of 3,100 ha. A scheme manager will be assigned for the management of each scheme. Scheme organization is shown in Fig. 15.2. Each scheme is subdivided into field operation units with the area of 400 ha. A field operation master is assigned for each field operation unit. He manages all the production process from land preparation through harvesting in the field operation unit.

15.2.2 Staffing and Expatriate Assistance

Number of staffs to be required for the execution of the project is estimated based on the data for the similar projects. Total number of staffs at the full operation stage is estimated to be 1,543 which consists of administrative staffs, specialists, engineers and regular employees. Besides, about 860 men-month seasonal emploees will be employed. Required number of the staffs from 1979 through 1988 is given in Table 15.2 togather with their specialities.

Sever shortage in experienced personnel exists in the country. Some specialists will have to be recruited from abroad for the assistance and guidance with the purpose of successful operation and maintenance of the project. The specialities of the experts to be invited are as follows. They gather from the Advisary Unit.

Speciality	No. of personnel
Irrigation Engineering	3
Civil Engineering	2
Construction Machinery	1
Farm Machinery	3
Rice Mill	2
Rice Agronomy	4

Table 15.1 Functions of the Departments and the Units

Department and Unit	
Department of Agricultural Production	- Farm machinery operations from land preparation through harvesting. - On-farm water management. - Plant protection. - Seed multiplication. - Research and training./1 - Operation and management of the rice mills. - Storage of paddy and milled rice.
Department of Engineering	- Operation and maintenance of irrigation facilities. - Control of irrigation water. - Maintenance of buildings. - Management of workshops. - Supervision of the construction of the irrigation and drainage facilities, road network and dike for the whole project area./2
Department of Finance and Commercial Affairs	- Financing and repayment of loan to the project. - All the money affairs associated with the project construction, operation and maintenance. - Payment of salaries. - Procurement, transportation and storage of all inputs. - Transporting of all outputs from the project site to Port Sudan. - All the works that concerns buying and selling. - Insurance for the equipments and products.

-to be continued-

	- Making general policies for commercial affairs. - Marketing of rice to foreign countries. - Studying of world market situation with respect to production, exports and consumption.
Department of Personnel and General Affairs	- Having the acts and ordinances observed that regulate personnel. - Training of administrative staff and specialists both at home and abroad. - Promotion of staff and employees. - Employment of seasonal employees. - Planning and scheduling of the social services. - Visiting and meeting with the farmers and local leaders in the neighboring area.
Planning Unit	- Formulation of overall yearly plan for the whole project. - Formulation of overall budget plan for the whole project. - Studies for finding the best way of controlling the production cost. - Evaluation and follow-up of the project. - Economic and social studies about the effect of the project.
Advisory Unit/3	- Assistance and guidance of the staffs of the Organization.

/1 Research and training will be done in cooperation with concerned government organizations at the Pilot Farm which will be established near the project area preceding the project.

/2 This function will be dropped after the completion of the project construction.

/3 This Unit will cease to exist after 1991.

Table 15.2 Required Number of Staff

1) Irrigation & Drainage Facilities and Farm Machinery	1979	1980	1981	1982	1983	1984	1985	1986	1987
Civil Engineer	1	2	2	3	4	4	3	2	0
Architect	1	2	2	3	3	3	1	1	0
Construction Machinery Engineer	1	2	2	3	4	2	2	2	0
Irrigation Engineer	0	0	1	1	2	3	4	5	5
Asst. Engineer	0	0	2	2	4	6	8	10	10
Surveyor	5	10	10	15	20	15	10	10	0
Field Overseer for Construction	8	18	18	28	36	30	18	16	0
Senior Field Agriculturist /1	0	0	5	5	10	15	20	25	25
Junior Field Agriculturist /1	0	0	6	8	14	19	29	37	40
Farm Machinery Engineer	0	0	1	1	2	3	4	5	5
Asst. Farm Machinery Engineer	0	0	2	2	4	6	8	10	10
Farm Machinery Operator /2	0	0	90	144	288	378	468	702	702
Canal Rider	0	0	8	11	17	24	35	44	44
Driver	5	5	20	32	64	84	104	156	156
Farm Labour	0	0	20	32	64	84	104	156	156
Seasonal /3	0	0	(100)	(160)	(320)	(420)	(520)	(780)	(780)
Sub-total	21	39	189	290	536	676	818	1,181	1,153
2) Workshop									
Mechanic	0	0	1	1	2	3	4	5	5
Regular Employee for Repair	0	0	5	5	47	52	57	62	62
Electrician	0	0	1	1	2	3	4	5	5
Sub-total			7	7	51	58	65	72	72

	1979	1980	1981	1982	1983	1984	1985	1986	1987
3) Operation of Rice Mill & Storage facility									
Plant Manager	0	0	1	1	2	3	4	5	5
Foreman	0	0	1	1	2	3	4	5	5
Engineer and Mechanic	0	0	4	4	8	12	16	20	20
Operator	0	0	4	4	8	12	16	20	20
Asst. Operator	0	0	6	6	12	18	24	30	30
Laborer	0	0	30	30	60	90	120	150	150
Seasonal /3	0	0	(16)	(16)	(32)	(48)	(64)	(80)	(80)
Sub-total	0	0	46	46	92	138	184	230	230
4) Administration									
Project Manager	1	1	1	1	1	1	1	1	1
Director	4	4	4	4	4	4	4	4	4
Scheme Manager	1	2	3	4	5	5	5	5	5
Administractive Officer	12	14	16	18	20	20	20	20	20
Accountant	6	6	6	6	6	6	6	6	6
Asst. Accountant	6	7	8	9	10	10	10	10	10
Clerk	8	10	12	14	16	16	16	16	16
Others	17	19	21	23	26	26	26	26	26
Sub-total	55	63	71	79	88	88	88	88	88
Grand Total	76	102	313	422	767	960	1,155	1,571	1,543

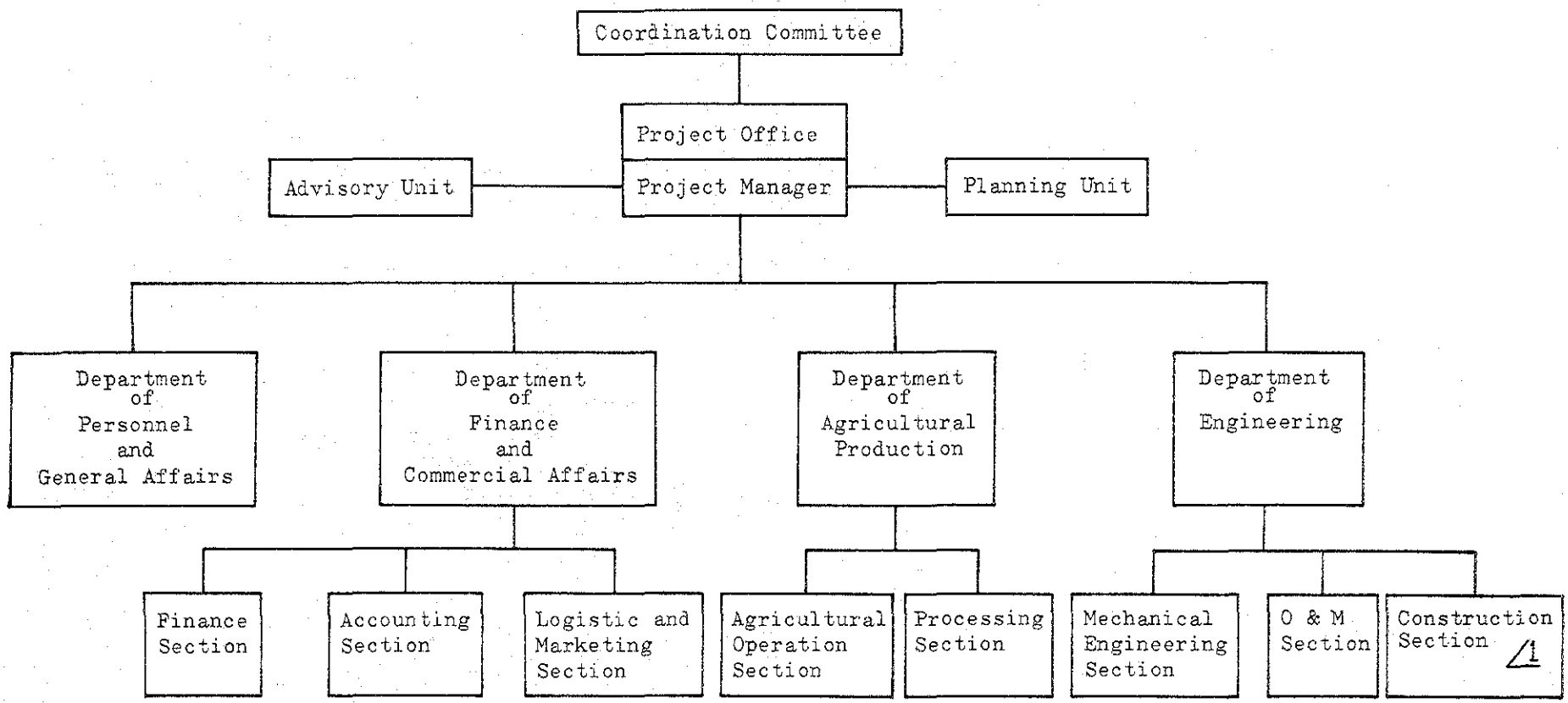
Note: This table does not include the members of the Advisory Unit.

/1 After 1991, senior and junior agronomists will not be required in the staff of the Organization

/2 Including farm machinery assistant operator

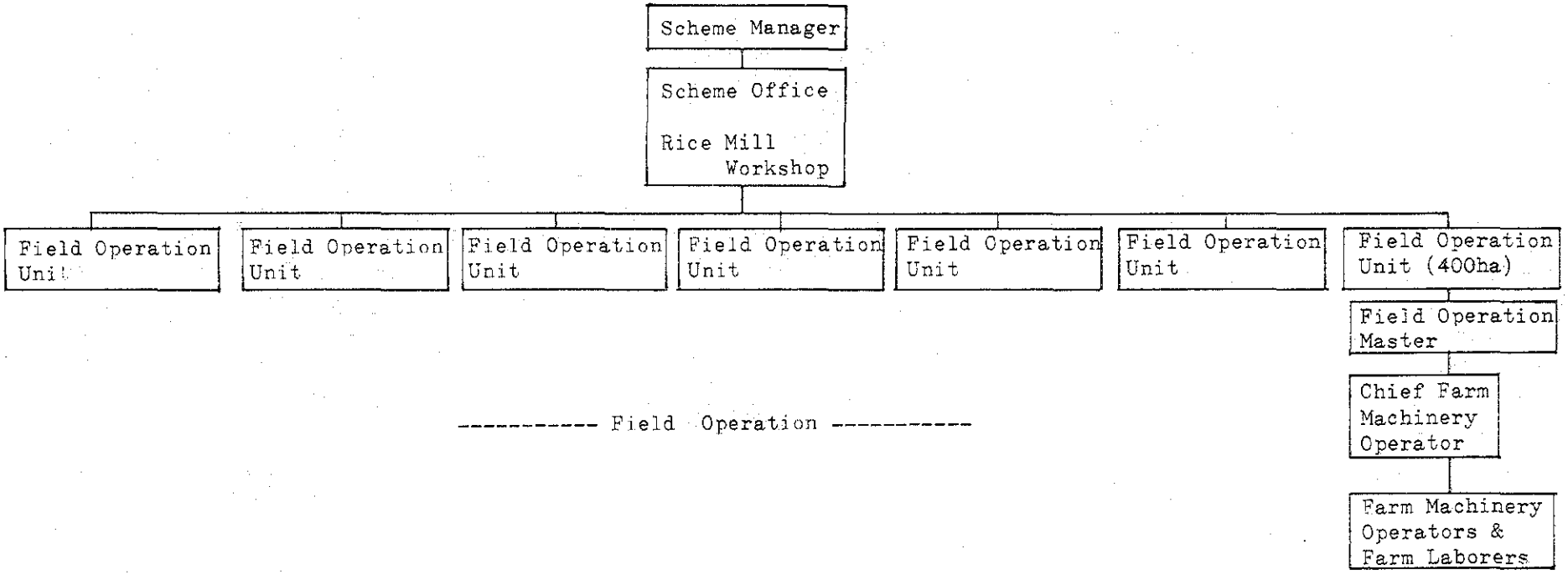
/3 Man-month

Fig. 15.1 Organization For The Executing Organization



/1 Disappear in and after 1987

Fig. 15.2 Scheme Organization



ANNEX XVI

MARKET AND PRICES

ANNEX XVI

MARKET AND PRICES

Tables

XVI. MARKET AND PRICES

16.1 Market for Rice

16.1.1 Introduction

Rice is the staple food of approximately half of the world's population. In many parts of Africa and the Middel East, rice is the "preferred" grain and in Asia it is the main source of calories. Rice may be regarded as one of the most important food stuff in the world. Despite this predominance, world's annual production of rice is roughly 230 million tons i.e., only about 65 % of annual wheat production[/1].

World's demand and supply of rice are both projected to increase by 2.4 % per annum between 1980 and 1985, and world's per capita consumption of rice is projected to increase from 57.3 kg to 58.7 kg between 1980 and 1985 as shown in Table 16.1.

In 1976/77, total production of rice in the Sudan was 12,000 t (paddy) and total domestic demand was 23,000 (paddy equivalent) as shown in Table 16.2. The deficit was made up by imported rice. According to the Six-Year Development Plan projection, rice production will be expended-both horizontally and vertically. Total area of rice field will be expanded from about 10,000 ha (24,000 fedds) in 1976/77 to 42,000 ha (100,000 fedds) in 1982/83. Average yield will be increased from 1.19 t/ha (0.5 t/fed) in 1976/77 to 1.35 t/ha (0.57 t/fed). Accordingly, total production will be raised from 12,000 t in 1976/77 to 57,000 t in 1982/83 (see Table 16.2). According to the projection, total demand will increase from 23,000 t to 43,000 (paddy equivalent) in the same period as shown in Table 16.3. Self-sufficiency will be attained in 1981/82 and from 1982/83 domestic production of rice will exceed domestic demand for rice. In 1982/83 or the last year of the Six-Year Development Plan, the production will surpass the demand by 14,000 t (paddy equivalent).

Providing that the construction of the Gasaba Project will be commenced in 1979 and will be completed in 1986, production will partially be started in 1981 when self-sufficiency of rice in the Sudan will already be attained, and reach full operation stage in 1987. Therefore, rice produced by the Gasaba Project will be exported abroad.

/1: "Price Prospects for Major Primary Commodities", IBRD, June 1977.

16.1.2 Market Prospect

The Sudan will be a new comer to the international rice market for rice export. She must compete with many other rice exporting countries. To compete with the exporting countries successfully, target countries as market for Sudanese rice should be chosen carefully paying due attention to the following factors:

a) Market size (Present and future)
b) Stability as market
c) Social, cultural and political ties with the Sudan
d) Comparative advantage of the Sudan

The names of rice importing Arab countries and the amount of rice imported by these countries in 1975 are shown in Table 16.4. Amount of rice totaled about 550,000 tons. The pupulation in 1976 and the growth rates of these countries are shown in Table 16.5. The total pupulation of these countries amounted to 67.58 million. If the growth rates of these countries given in the Table remain constant, total pupulation in 1987 when the Gasaba Project will reach full operation stage will be increased to 94.88 million, or about 1.4 times as large as in 1976. Assuming per capita consumptions of rice in these countries are the same and will not change till 1987, total demand for rice in these countries will be 1.4 times as much as that in 1976. Assuming the import of rice increase in proportion to pupulation increase, the total amount of rice which will be imported by the Arab countries in 1987 will be more than 770,000 tons.

Mean while GDP, GDP per capita and its growth rates of those countries are shown in Table 16.6. GDP per capita growth rates vary between 7.5 % and 17.2 % with the average value of 34 %. As GDP per capita increases, per capita consumption of rice increases. Amount of the increment depends on the value of the income elasticity of demand for rice. Assuming income elasticity of 0.2[/1] and annual GDP per capita growth of 10 %, expenditure on rice consumption will increase by about 2 % of the GDP per capita annually. In other words, about 20 % of the GDP per capita increment will be spent on rice consumption every year.

/1: World income elasticity of demand. "Price Prospects for Major Primary Commodities", IBRD, June 1977.

The amount of rice produced by the Project will be about 110,000 tons (milled rice) at full operation stage. It can be concluded, therefore, the Arab countries will be big enough as a rice export market for Sudanese rice.

In Table 16.7, distance, number of sailing days and approximate transportation cost (bunker charge) from major rice exporting countries and the Sudan to the Arab countries are shown. It is clear from the Table that the Sudan can enjoy favorable position as rice exporting country for many Arab countries. Saudi Arabia, for example, is very close to the Sudan and it takes only one day to arrive whereas it takes 33 days from U.S.A.

Social, cultural and political ties between the Sudan and the Arab countries are strong and stable. By concluding bilateral agreements with the countries, they will be stable market for Sudanese rice.

16.2 Prices

16.2.1 General

Wholesale prices of principal agricultural commodities in Kosti District in 1974 and 1975 are shown in Table 16.8. The prices of sorghum, millet and groundnuts were raised from 1974 to 1975 while the price of wheat was fixed and the price of sesame went down. Export prices of cotton from the 1970/71 fiscal year to 1975/76 fiscal year are given in Table 16.9. Though the prices of both kinds of cotton on the whole went up from the 1970/71 fiscal year to the 1975/76 fiscal year, they experienced drops in some years during the those periods. The farm gate price of wheat is determined by the Government./1 The prices are £s. 40 per ton, £s. 65 per ton, £s. 65 per ton and £s. 75 per ton in the fiscal year 1973/74, 1974/75, 1975/76 and 1976/77, respectively. The rice produced in the Sudan Gezira Board were sold to whole salers at the price of £s. 250 per ton from 1974 through 1976. The retail price was £s. 0.33 per kg during this period.

/1: See Section 6.1.6.

16.2.2 Price Prospect of Rice

According to the Six-Year Plan, the Sudan will attain self-sufficiency of rice in 1981/82. Afterwards, domestic production will exceed domestic demand for rice and the surplus including the rice produced by the Gasaba Project would be exported abroad. International market price of rice[/1], therefore, be applied for the price of rice produced by the Project.

Forecasted prices of rice in 1977 constant dollars and in current dollars in the international market projected by IBRD are given in Table 16.10 and Table 16.11, respectively together with adual data in the past. Price of rice goes up gradually until it becomes almost constant in 1980 at the price of US$390 per ton in 1977 constant dollars.

In the short range, as IBRD forecasts, demand and supply of rice will be in balance. In the long range, however, demand seems to be stronger than supply. World pupulation has been increasing rapidly and the growth rate is likely to remain high in the future. As shown in Table 16.12, annual growth rate of the world pupulation from 1975 through 1985 is 1.96 %. In other words, the world pupulation will be doubled after 35 years. The corresponding figure for developing countries where more than half of rice was consumped and more than three fourths of internationally traded rice was imported in 1976, is 2.69 %. The total pupulation of these countries will be doubled after about 26 years. Detailed data for pupulation growth trend are given in Table 16.12. On the other hand, agricultural production including rice production can expand at slower rate than pupulation growth.

It can be expected, therefore, that in the long run demand for rice will be stronger than supply of rice. Under the circumstances, rice price seems to be kept at high level in the long run.

The economic and financial mill gate price of rice which will be produced by the Gasaba Project will be estimated on the basis of the international market prices projected by the IBRD, taking associated costs such as transportation costs from the project area to Port Sudan into consideration. The details are given in Table 16.13 and Table 16.14, respectively.

/1: Thai Bangkok f.o.b., 5 % broken.

16.2.3 Prices of Farm Inputs

According to the IBRD price forecast/1 published in June 1977, economic and financial prices of fertilizers will steadily go up from 1977 till 1985 as shown in Table 16.15 and Table 16.16. Both economic and financial prices/2 of fertilizers for the Gasaba Project are estimated based on the forecast. Economic and financial farm gate prices of fertilizers are estimated by deducting associated costs such as port charge, storage cost and transportation cost from the economic and financial prices.

Both economic and financial prices/2 of agro-chemicals/3 for the Gasaba Project are estimated on the assumption that they will follow a similar price trend as fertilizers. Economic and financial farm gate prices of agro-chemicals are estimated by deducting associated costs from the economic and financial prices.

The economic and the financial farm gate prices of the farm inputs are given in Table 16.17.

/1: "Price Prospects for Major Primary Commodities", IBRD, June 1977.

/2: C.I.F. price at Port Sudan.

/3: Fungicide, insecticide, herbicide and fungicide for seed treatment.

Table 16.1 Rice (Milled): Summary of Projection, Consumption and Trade by Economic Regions

	Actual							Forecast			Growth Rates		
	1955	1961-63	1970	1971-73	1974	1975	1976/2	1977	1980	1985	1961/63 to 1970	1970-80	1980-85
	(million metric tons)										(-- percent per annum --)		
Production													
Developed Countries	13.8	15.0	14.5	14.1	15.0	15.8	14.5	14.5	15.5	17.5	-0.4	0.7	2.5
Developing Countries	69.0	93.2	113.3	115.1	119.3	131.0	127.1	130.0	140.0	160.0	2.5	2.2	2.7
Centrally Planned Economies/1	55.0	54.3	76.5	78.4	88.8	90.7	91.1	92.0	97.0	110.0	4.4	2.2	2.0
World	138.3	162.5	204.3	207.6	223.1	237.5	232.7	236.5	250.5	282.5	2.9	2.1	2.4
Consumption													
Developed Countries	13.9	14.4	12.8	12.0	13.1	13.7	12.9	12.5	13.0	13.7	-1.5	0.2	2.0
Developing Countries	69.0	93.0	115.0	117.2	122.1	133.8	129.0	132.2	144.5	168.0	2.7	2.3	3.1
Centrally Planned Economies/1	55.4	54.2	76.5	78.4	87.9	90.0	90.8	91.8	95.0	105.8	4.4	2.2	2.2
World	138.3	161.6	204.3	207.6	223.1	237.5	232.7	236.5	250.5	282.5	2.3	2.1	2.4
Exports													
Developed Countries	0.8	1.3	2.6	2.84	2.65	2.80	2.61	3.10	3.5	5.0	9.1	3.0	7.4
Developing Countires	4.0	4.4	3.8	3.41	2.67	2.77	4.17	3.72	4.0	3.0	-1.9	0.5	-5.8
Centrally Planned Economies/1	0.7	0.6	0.9	1.29	2.00	1.60	1.00	0.90	2.5	4.5	5.2	10.8	12.5
World	5.5	6.3	7.3	7.54	7.32	7.17	7.78	7.72	10.0	12.5	1.9	3.2	4.6
Imports													
Developed Countries	1.3	0.9	0.9	0.76	0.72	0.72	1.12	0.92	1.0	1.2	0.0	1.1	3.8
Developing Countries	3.6	4.7	5.5	5.51	5.48	5.61	5.90	6.00	8.5	11.0	2.0	4.5	5.3
Centrally Planned Economies/1	0.6	0.4	0.9	1.27	1.1	0.90	0.70	0.80	0.5	0.3	10.7	-6.1	-10.7
World	5.5	6.0	7.3	7.54	7.32	7.23	7.72	7.72	10.0	12.5	2.5	3.2	4.6
Per Capita Consumption/3	(kilograms)												
Developed Countries	21.9	20.6	17.7	16.3	17.4	18.1	16.9	16.2	16.4	16.6	-1.9	-0.8	0.3
Developing Countries	58.7	66.5	66.0	63.9	63.2	67.5	63.4	63.3	63.8	65.0	-0.1	-0.3	0.4
Centrally Planned Economies/1	60.6	53.9	67.0	66.7	72.7	73.3	72.9	72.7	72.1	75.4	2.8	0.8	0.9
World	50.8	52.1	56.6	55.4	57.3	59.9	57.5	57.3	57.3	58.7	1.1	0.1	0.5

/1 The People's Republic of China, Khmer, Vietnam, Eastern Europe and USSR.
/2 Provisional.
/3 Food and non-food uses.

Source: Economic Analysis and Projections Department, IBRD, 1977.

Table 16.2 Actual and Projected Production and Demand for Rice in the Sudan

	76/77	82/83
Average Yield	1.19 t/ha (0.5 t/fed)	1.35 t/ha (0.57 t/fed)
Area	10,080 ha (24,000 fedds)	42,000 ha (100,000 fedds)
Production	12,000 t	57,000 t
Demand	23,000 t	43,000 t

Source; "Six-Year Development Plan", Ministry of National Planning.

Table 16.3 Total Demand for Rice in Sudan

(Based on Six-year Plan)

Year	Per Capita Consumption (kg/year)	Milled Rice (10^3 tons)	Paddy (10^3 M.T.)
1974/75	0.7	11	16
1975/76	0.8	13	19
1976/77	0.9	15	23
1977/78	1.0	17	25
1978/79	1.1	19	28
1979/80	1.2	21	31
1980/81	1.3	24	35
1981/82	1.4	26	39
1982/83	1.5	29	43

Source: Statistical Year Book, Democratic Republic of the Sudan, May 1977 and "Six-Year Development Plan", Ministry of National Planning.

Table 16.4 Amount of Rice Imported by Main Arab Countries in 1975

Name of the countries	Amount of rice (tons)	Value in U.S.$ x 1,000
Saudi Arabia	220,000	86,000
Iraq	120,380	65,996
Syria	50,056	24,756
Kuwait	50,000	28,000
Dem. Rep. of Yemen	36,000	10,500
Oman	26,500	8,000
Lebanon	21,000	9,500
Jordan	11,413	5,844
North Yemen	4,700	3,100
Algeria	5,700	2,800
Tunisia	1,100	550
Total	546,849	244,846

Source: Trade Yearbook, FAO 1975

Table 16.5 Population and Its Growth of Major Arab Countries

Name of the countries	Population millions 1976	Growth Rate (%)
Saudi Arabia	9.24	3.0
Iraq	11.51	3.5
Syria	7.60	3.4
Kuwait	1.03	3.0
Dem. Rep. of Yemen	1.76	4.14
Oman	0.79	2.6
Lebanon	2.96	3.13
Jordan	2.78	2.96
North Yemen	6.87	3.0
Algeria	17.30	3.1
Tunisia	5.74	2.3
Total	67.58	2.85

Source: Monthly Bulletin of Statistics, United Nations, July, 1977.

Table 16.6 GDP, GDP/Capita and Its Growth Trend of Major Arab Countries

Name of the countries	Gross domestic product (mill.$)		GDP/Capita (U.S. $)		GDP/Capita Growth(%)
	1973	1974	1973	1974	
Saudi Arabia	9,771	27,362	1,190	3,237	172.0
Iraq*	4,332	4,949	382	429	12.0
Syria	2,463	3,889	358	546	52.5
Kuwait	7,158	11,022	8,134	11,852	45.7
Dem. Rep. of Yemen*	142.1	167	99	-	-
Oman	-	-	-	-	-
Lebanon*	1,488	2,086	603	796	32.0
Jordan	807	937	318	358	12.6
North Yemen*	725	811	120	129	7.5
Algeria	6,139	7,527	402	477	18.7
Tunisia	2,791	3,533	513	626	22.0

Note: GDP/Capita growth is calculated based on the figures in 1973 and 1974 except those with * mark.

Source: Monthly Bulletin of Statistics, United Nations, July, 1977.

Table 16.7 Transportation Cost between the Rice Importing Arab Countries and the Rice Exporting Countries and the Sudan

Sudan and Exporting Countries	Importing Countries						
	Kuwait (Kuwait)	Saudi Arabia (Jeddah)	Algeria (Algier)	Iraq (Basrah)	Syria (Lattakia)	Jordan (Aquaba)	Lebanon (Beirut)
Thailand (Bangkok)	4,709	5,174	-	4,724	-	-	-
	13	15	-	13.5	-	-	-
	273,000	315,000	-	283,500	-	-	-
Pakistan (Karachi)	1,111	4,111	4,352	1,171	-	-	-
	3	12	12	3.5	-	-	-
	63,000	252,000	252,000	73,500	-	-	-
U.S.A. (San Fran.)	11,274	11,739	-	2,630	-	-	-
	33	33	-	8	-	-	-
	693,000	693,000	-	168,000	-	-	-
China P.R. (Shanghai)	6,060	-	8,693	-	7,530	7,284	-
	17	-	24.5	-	21	20.5	-
	357,000	-	514,500	-	441,000	430,500	-
Korea (Incheon)	7,364	-	-	-	7,904	7,658	-
	21	-	-	-	22	20.5	-
	441,000	-	-	-	462,000	430,500	-
India (Bombay)	1,616	4,616	-	-	-	-	-
	5	13	-	-	-	-	-
	105,000	273,000	-	-	-	-	-
Bahrain (Bahrain)	-	2,500	-	-	-	-	-
	-	7	-	-	-	-	-
	-	147,000	-	-	-	-	-
Italy (Genoa)	-	-	530	-	1,450	-	-
	-	-	2	-	4.5	-	-
	-	-	42,000	-	94,500	-	-
Peru (Callao)	-	-	-	14,538	-	-	-
	-	-	-	41	-	-	-
	-	-	-	861,000	-	-	-
Egypt (Alex.)	-	-	-	-	-	393	337
	-	-	-	-	-	1.5	1
	-	-	-	-	-	31,500	21,000
Sudan (P. Sudan)	3,005	165	2,300	2,630	1,101	855	1,033
	8.5	1	6.5x2	8	3.5x2	2.5	3x2
	178,500	21,000	273,000	168,000	147,000	52,500	147,000

Note: Figure in the upper : Distance (Sea miles)
- do - Middle: Sailing Days
- do - Lower : Bunker Charge (US$)

Source : Nippon Yusen Co., Ltd.

Table 16.8 Wholesale Prices of Principal Agricultural Commodities in Kosti District

(£S/t)

	Sorghum (Feterita)	Millet	Groundnuts in shell	Sesame	Wheat
1974	38.2	53.1	72.2	140.7	74.0
1975	40.9	67.1	74.9	122.2	74.0

Source: Department of Agricultural Economics, Ministry of Agriculture, Food and Natural Resources.

Table 16.9 Export Price of Cotton

(£S/t)

	70/71	71/72	72/73	73/74	74/75	75/76
Barakat /1	253.6	249.0	387.6	480.8	396.5	554.7
Acala /2	192.5	278.8	314.8	275.7	320.1	461.1

/1: Long-staple cotton

/2: Medium-staple cotton

Source: Cotton Marketing Corporation

Table 16.10 Rice Price and Price Projection in 1977 Constant Dollars /1

(US$/ton)

Average			Actual				Partially Estimated		Projected		
1967/69	1970/72	1960/69	1970	1974	1975	1976	1977	1978	1979	1980	1985
447.5	269.7	271.7	297.5	668.3	396.3	273.7	270.0	305.6	344.5	390.2	390.1

/1 Thai Bangkok f.o.b., 5 % broken.

Source: "Price Projects of Major Primary Commodities," IBRD, June 1977

Table 16.11 Rice Price and Price Projection in Current Dollars /1

(US$/ton)

Average			Actual			Partially Estimated		Projected				
1967/69	1970/72	1960/69	1970	1974	1975	1976	1977	1978	1979	1980	1985	1987 /2
198.1	140.0	158.9	144.0	542.0	363.0	254.5	270.0	330.0	400.0	485.0	680.0	778.5

/1 Thai Bangkok F.O.B., 5 % broken.

/2 Forecasted on the basis of the recent price trend.

Source: "Price Projects of Major Primary Commodities", IBRD, June 1977

Table 16.12 Estimated and Projected World Population, 1965-1985

	mid-1975 (million)	1965-1975 (% per annum)	1975-1985 /a (% per annum) (growth)
Developed Countries /b	739.5	0.92	0.92
Developing: Major Oil Exporters	294.4	2.78	2.83
Other /c	1679.9	2.55	2.66
(low income)	(1050.2)	(2.48)	(2.63)
(middle income)	(629.7)	(2.66)	(2.72)
Sub-total: Developing	1974.3	2.58	2.69
Centrally Planned Economics	1253.2	1.46	1.36
World	3967.0	1.90	1.96

/a The projection represents the medium variant series produced by the Population Division of the U.N. Secretariat.

/b Developed countries here include Greece, Portugal and Spain.

/c Developing countries other than major oil exporters are divided into two groups by per capita income of 1973: low-income countries are those below $200, and middle-income countries (including Turkey and Yugoslavia) are $200 and above.

Source: U.N. Secretariat, Population Division: "Single-Year Population Estimates and Projections for Major Areas, Regions and Countries of the World, 1950-2000," October 6, 1975.

Table 16.13 Economic Price of Rice (Export)

International Market Price	US$390.1/t
Applying Shadow Exchange Rate £S 1 = US$2	£S195.1/t
Loading, Port Charge	£S3.8/t
Storage and Insurance Costs	£S2.6/t
Transportation Cost from Mill Gate to Port Sudan/1	£S12.7/t
Economic Price of Rice at Mill Gate	£S176.0/t

/1: From project area to Khartoum by trailer.
From Khartoum to Port Sudan by train.
The breakdown is shown as follows:

- Price of truck-trailer
  Truck: £S 17,000, Useful life = 2 years
  Trailer: £S 8,000, Useful life = 10 years Capacity = 30 ton
- Total workdays of truck-trailer
  250 days/year
- Milled rice production from the project
  10 ton/ha x 15,600 ha x 0.70 = 109,200 ton/year
- Required number of truck-trailer
  109,200 ton/year ÷ 250 days/year ÷ 30 ton = 15 nos/day
  Stand-by: 8 nos.
- Investment cost
  Truck 17,000 £S/nos x 23 nos. = £S 391,000
  Trailer: 8,000 £S/nos x 23 nos. = £S 184,000
  Spare parts: £S 9,000/year
- Estimation of transportation Cost

i)	Annual cost (Truck-trailer)					
	Truck:	391,000 £S	÷ 109,000 ton	÷ 2 year	=	£S 1.79/ton
	Trailer:	184,000	÷ 109,000	÷ 10	=	£S 0.17/ton
	Spare parts:	9,000	÷ 109,000		=	£S 0.08/ton
				Sub-total		£S 2.04/ton
ii)	O & M cost					£S 1.27/ton
iii)	Personnel expenses					£S 0.14/ton
iv)	Transportation cost by the train					£S 8.7 /ton
v)	Loading and unloading					£S 0.5 /ton
				Total		£S12.65/ton ≈ £S12.7/ton

Table 16.14 Financial Price of Rice /1 (Export)

International Market Price	US$ 778.5/t
Applying Effective Exchange Rate £S 1 = US$ 2.55	£s 305.3/t
Loading, Port Charge	£s 14.4/t
Storage and Insurance Costs	£s 9.8/t
Transportation Cost from Mill Gate to Port Sudan /2	£s 48.0/t
Financial Price of Rice at Mill Gate	£s 233.1/t

/1: At full operation stage

/2: From project area to Khartoum by trailer
From Khartoum to Port Sudan by train

Table 16.15 Fertilizer Prices and Price Projections in 1977 Constant Dollars

(US$/ton)

Commodity	Average			Actual				Partially Estimated	Projected			
	1967/69	1970/72	1960/69	1970	1974	1975	1976	1977	1978	1979	1980	1985
Phosphate Rock	26.2	21.7	29.0	22.7	67.2	73.1	38.7	33.8	33.8	35.0	34.9	39.3
Triple-super-phosphate	93.5	98.9	93.5	88.8	374.8	220.5	97.8	103.7	109.2	115.7	123.3	160.4
DAP	145.3	132.9	341.1	111.6	410.6	265.3	129.0	144.1	148.4	155.0	163.6	223.7
Urea	151.4	98.3	183.1	99.2	389.6	215.9	121.5	133.1	139.7	145.2	152.7	189.8
Potassium Chloride	54.2	63.6	66.5	66.1	75.2	88.8	59.1	56.8	60.0	61.2	61.1	69.8

Source: "Price Prospects for Major Primary Commodities", IBRD, June 1977.

Table 16.16 Fertilizer Prices and Price Projection in Current Dollars

(US$/ton)

Commodity	Average			Actual				Partially Estimated	Projected			
	1967/69	1970/72	1960/69	1970	1974	1975	1976	1977	1978	1979	1980	1985
Phosphate Rock	11.6	11.3	12.3	11.0	54.5	67.0	36.0	33.8	36.5	40.6	43.4	68.5
Triple-super-phosphate	41.3	51.3	41.3	43.0	304.0	202.0	91.0	103.7	117.9	134.3	153.2	279.6
DAP	64.3	69.0	144.7	54.0	333.0	243.0	120.0	144.1	160.3	180.0	203.4	389.9
Urea	67.0	51.0	78.1	48.2	316.0	197.8	113.0	133.1	150.9	168.6	189.8	330.9
Potassium Chloride	24.0	33.0	28.2	32.0	61.0	81.3	55.0	56.8	64.8	71.0	75.9	121.7

Source: "Price Prospects for Major Primary Commodities", IBRD, June 1977.

Table 16.17 Economic and Financial Prices of Farm Inputs

(Unit: £s/kg)

Item	Economic/1	Financial/2
Fertilizer		
Urea	0.120	0.274
Compound/3	0.105	0.250
Agro-chemicals		
Fungicide	0.468	0.876
Insecticide	0.379	0.720
Herbicide	0.636	1.164
Fungicide/4	13.476	23.318

/1: Estimated on the basis of IBRD forecast, which was published in June 1977, for 1985.

/2: Estimated for the full operation stage on the basis of IBRD forecast published in June 1977.

/3: Triple-superphosphate.

/4: For seed treatment.

Note: Seed will be provided from the Pilot Farm.

ANNEX XVII

COST ESTIMATE

ANNEX XVII

COST ESTIMATE

Tables

XVII. COST ESTIMATE

17.1 General

The costs for the execution of the Gasaba Project is estimated on the basis of preliminary design of the project works taking into account the construction technics to be adopted, productivity of labor, natural environment of the project area and the economic and social background of the country. The following assumptions are made for the estimation of the required costs.

i) Major items of construction machinery, farm machinery and rice processing facilities and materials such as steel, fertilizer and agro-chemicals will be procured by international open tender:

ii) All the project works will be implemented by contract basis. The detail design and the supervision of the construction of the project will be undertaken by foreign consultants. The construction of major project works will be undertaken by foreign contractors. The construction of buildings and ancillary works will be done by local contractors.

iii) The land which is to be trnasformed into canals by the project will be acquired at the price of £s.60 per ha.

iv) Physical contingencies of the cost estimate are 15 % for the civil works, engineering service and the procurement for machinery and equipment, and 10 % for the initial farm investment and the processing facilities.

v) Price contingency applied in the estimate are as follows:

Equipments imported	8 % from 1977 to 1979.
	7 % from 1980 onward.
Foreign currency component	12 % from 1977 to 1979.
of civil works	10 % from 1980 onward.
Local currency component	8 % throughout the construction period;

vi) Price level for the cost estimate is principally October 1977.

vii) The conversion rate from local currency to foreign currency is £s.1.0 = US$ 2.55.

17.2 Project Cost

The project cost comprises; (a) cost for the civil works including the land acquisition cost, (b) cost for the processing and storage facilities, cost for the workshops and building facilities, and (c) cost for initial farm investment.

17.2.1 Construction Cost of Civil Works

Construction cost of the civil works is broadly divided into four categories; (i) cost for preparatory works, (ii) cost for major construction works, (iii) procurement cost of construction machinery, and (iv) cost for engineering services.

Construction cost of the civil works is estimated based on the following assumptions in addition to those stated in Section 17.1.

- Unit price analysis is made based on the operation cost and capacity of machinery to be used.
- About 10 % of total amount of earth-moving work are handled by manpower for its finishing.
- Embankment is executed by using the excavated materials from the nearest place in principle. Only insufficient materials for embankment are conveyed by dump trucks from the borrow pits.
- The procurement costs of construction machinery delivery at the project site are estimated as follows.

  Unit price = CIF price at Port Sudan + Inland transportation costs from Port Sudan to Ed Dueim.

  Spare parts and consumables = 40 % of total procurement cost.
- All construction machinery are assumed to be fully depreciated at the end of works.

Construction cost of the civil works estimated is shown in Table 17.1. The estimated costs for civil works are £s.51.9 million. More detailed breakdown of the cost is given in Table 17.2(1) to (5). The procurement cost for the construction machinery is shown in Table 17.3.