CHAPTER 5 BASIC DESIGN

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5.1 Land Consolidation for Agricultural Production

5.1.1 Basic Concept

(1) Irrigation plan

The following concepts with respect to the irrigation plan are applied in the project taking into consideration such factors as runoff of the Yongoma river, irrigable area, cropping pattern and so forth.

- The development area of the project, where all lands will be reclaimed to become suitable for paddy cultivation, should be the maximum irrigable area in the rainy season using the runoff of the Yongoma river. The area should be demarcated assigning priority to the land classification suitability for paddy cultivation, the existing farm land distribution and the land not to be damaged by flooding of the Kambaga and the Hingilili rivers.

- Irrigable area should be decided taking into account runoff of the Yongoma river, irrigation water requirements, discharge for the rural water supply system and existing water rights in the river.

- The rotational irrigation method should be applied in this area because of its ease of water management and operation for canal related structures.

- The irrigation canal system and canal related structures should be arranged taking such factors as economical construction costs, construction methods, irrigation efficiency and so forth into consideration. Main and secondary irrigation canals are to be lined with concrete blocks aiming at making maximum use of limited irrigation water, and protecting against water loss through seepage in the canal. The small canal structures are to be constructed by using pre-casted materials to shorten the construction period.

(2) Drainage plan

Drainage conditions in this area are extremely inferior for the following reasons:

- The river course of the Yongoma river, which flows into the area from west to east, disappears in almost the middle of the project area,
- Flooding that occur in the Hingilili river and the Kanbaga river flow into the area from the north side and east side, and
- There is no drainage canal system in this area.

To improve the above drainage conditions, the following basic concepts are being adopted in the formulation of the drainage plan.

- River training work for the Yongoma river should be done to drain the flood discharge immediately to an area outside of the development area,
- To protect the development area against flooding from the Hingilili river and the Kanbaga river, farm roads to be worked as flood dikes should be constructed around the development area,
- The drainage canal system in the development area should be planned so as to immediately drain out any excess water in the area. Catch drains should be provided outside the area to drain any flooding from the hinterland.
- The type of drainage canals should be an unlined earth canal to save on construction costs.

(3) Farm roads and on-farm development

Main and branch farm roads should be arranged taking in account easy operation and maintenance for the canals and related structures and smooth transportation of farm products. The standard farm plot should be decided taking into consideration factors such as plowing by tractors and future mechanized farming.

5.1.2 Determination of Basic Figures

(1) Runoff of the Yongoma river

The runoff of the Yongoma river is the sole water source for the project. A runoff estimate for the river, therefore, is very important in order to demarcate the irrigable area. An estimate was made during the previous feasibility study carried out in 1982 and 1983 using the discharge records from 1963 to 1982 of the Sesani and the Hingilili rivers, since there was no discharge record on the Yongoma river (see Section 3.2.4). On the other hand, the discharge of the Yongoma river has been observed by RDD's office since 1983. Using these observed data, the estimated runoff from the feasibility study are examined as shown in Fig. 5.1.1.

According to the results of the comparison between the estimated runoff from the feasibility study and the observed runoff from 1983 to 1985, it is found that the estimated runoff from the feasibility study is reliable for demarcation of the irrigable area. The average monthly runoff is tabulated in Table 5.1.1, using the estimated runoff (1963-1982) from the feasibility study and the observed runoff from 1983 to 1985. These runoff data are summarized as follows:

(Unit: m^3/sec)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Ave.
1.90	1.34	1.53	1.68	1.19	0.81	0.56	0.49	0.45	0.45	0.45	0.45	1.20

(2) Irrigation water requirements

Irrigation water requirements are estimated based on the following concepts using the data collected during the feasibility study and during the field survey of this basic design study.

- Consumption of water is calculated by multiplying the potential evapotranspiration, which is estimated, by the modified Penman method, by crop coefficient, which is established by FAO.
- Percolation rate in the paddy field is 2 mm/day in the dry season and 1 mm/day in the rainy season.
- Plowing and puddling water requirements are 50 mm/5 days and 130 mm/5 days, respectively.

- Effective rainfall is estimated by the daily water balance method using the daily rainfall records.
- Irrigation efficiency is assumed at 72%, consisting of an application efficiency of 95%, operation efficiency of 85% and conveyance efficiency of 90%.

Monthly average unit diversion requirements are summarized in the following table by estimations in accordance with the above conceptions. Meteorological data at Kalimawe meteorological station are figured in Fig. 5.1.2 and tabulated in Table 5.1.2, respectively. Unit semi-monthly field water requirements are shown in Table 5.1.3 and unit monthly diversion water requirements are also shown in Table 5.1.4 for each respective year from 1963 to 1985.

(Unit: ℓ/sec/ha)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Unit diversion water requirements	0.46	0.55	0.98	0.89	0.96	0.34	0.0	0.005	0.36	1.39	1.16	1.15

Unit peak diversion water requirements in the rainy and dry season are as shown below:

(Unit: ℓ/sec/ha)

	Monthly	Semi-monthly
Dry season	1.50	1.61
Rainy season	1.31	1.36

(3) Water balance study

A water balance study is carried out based on the estimated runoff and the unit diversion water requirements. The water requirement for the rural water supply system, 13.8 ℓ/sec, and the water for sisal estates, 74.6 ℓ/sec, which is granted by water rights to the Yongoma river is taken into account. For this study, the following procedure is applied:

- Gross diversion water requirements, which are estimated in an assumed irrigation area for the rainy and dry seasons, are respectively compared with the runoff of the Yongoma river during each month from 1963 to 1985.

- If there is a month when runoff is short even once a year, the year is judged as a drought year. Probability analysis of the drought years during the twenty three years from 1963 to 1985 is done against the assumed irrigation area.

- The same methods mentioned in the above items are repeated for several assumed irrigation areas, and these results are plotted on lognormal probability paper.

- Based on the above plotted figure, an irrigation area with a dependability of 80%, namely a drought year occurs once in five (5) years, is an irrigable area for this project both in the rainy and the dry seasons.

According to the results of the water balance study carried out through the above procedures, irrigable areas of 680 ha and 230 ha are estimated for the rainy season and dry season, respectively. The results of the water balance study are shown in Fig. 5.1.3 and Table 5.1.5.

(4) Flood discharge of Yongoma river

Flood discharge of the Yongoma river is estimated by applying the following procedure, using the data collected during the feasibility study and this basic design study.

- Peak flood discharge is estimated by using the Rational formula as shown below:

$$Qp = 1/3.6 \times re \times A \quad \cdots\cdots\cdots\cdots \quad ①$$

where, Qp: peak flood discharge (m^3/sec)
re: effective rainfall intensity for the duration equal to the flood concentration (mm/hr)
A: catchment area (A = 70.5 km^2)

- Flood concentration time of the Yongoma river is given by the following equation:

$$Tp = n \times re^{-c} \times A^{d} \quad \cdots\cdots\cdots\cdots \quad ②$$

where, Tp : flood concentration time (min)
m : coefficient (=242)
c : coefficient (=0.433)
d : coefficient (=0.22)

Coefficients of m and c were estimated during the feasibility study.

- Rainfall intensity can be calculated by using the following equation:

$$rt = R_{24}/t \times (t/24)^k \quad \text{..... ③}$$

where, rt : rainfall intensity during t hours (mm/hr)
R_{24} : daily rainfall (mm/day)
t : time in hours (hr)
k : coefficient (=1/3)

- Basin rainfall of the Yongoma river is calculated by applying the isohyetal analysis method (ref. Fig. 5.1.4) as follows:

$$RY = 0.40 \times RT + 0.60 \times RG$$

where, RY : basin rainfall of Yongoma river (mm/day)
RT : rainfall at Tia dam site (mm/day)
RG : rainfall at Gonja estate (mm/day)

- Annual maximum basin rainfall in each year is estimated by using the above equation, and probable basin rainfall is also calculated using the calculated annual maximum basin rainfall. These results are shown in Table 5.1.6.

- Effective rainfall intensity during t hours is calculated by using the following equation:

$$re = r \times rt \quad \text{..... ④}$$

where, re : effective rainfall intensity during t hours (mm/hr)
r : peak runoff coefficient (=0.5)
rt : rainfall intensity during t hours
(obtained by using the equation-③)

- The flood concentration time (Tp) and the effective rainfall intensity (re) for the duration equal to the flood concentration time of the Yongoma river

are estimated by reading the figure in Table 5.1.7. This figure is illustrated by using the probable basin rainfall and equations ②, ③and ④. Then, peak flood discharges of the Yongoma river for multiple year return periods are calculated by using equation-①.

Peak flood discharge estimated in accordance with the above procedure is summarized as below for each return period in a year.

	Return Period in Years						
	2	5	10	20	50	100	200
Peak flood discharge (m3/sec)	53	80	102	121	149	172	196

(5) Drainage water requirements

Drainage water requirements for the development area (paddy fields) and the hinterland are calculated respectively as follows:

1) Drainage water requirements in the development area (paddy fields)

Requirements are estimated based on the following criteria:

- The design rainfall is a two-day consecutive rainfall at the Kalimawe meteorological station.
- The excess water from the design rainfall drains over two days.
- Storage capacity in paddy fields is 40 mm on the an average.

The unit drainage water requirements in the development area are calculated by using the following equation and are summarized below:

$$q = (R-S) \times 10{,}000/3{,}600 \times 48$$

where, q : unit drainage requirement (ℓ/sec/ha)

R : design rainfall (mm)

S : storage capacity in paddy fields (=40 mm)

	Return Period in Years				
	2	5	10	20	50
Design rainfall (mm)	62	90	113	135	177
Unit drainage requirements (*l*/sec/ha)	1.27	2.89	4.22	5.50	7.93

2) Drainage water requirements from the hinterland

Drainage water requirements from the hinterland are estimated by using the specific discharge calculated by the same method as in the estimation of the peak flood discharge for the Yongoma river mentioned in the previous section, because flood concentration time changes with the respective drainage area. The specific discharge for each respective drainage area is figured in Fig. 5.1.5 with each yearly return period. The drainage requirements, then, are estimated by using the following equation.

$$Q = q \times A$$

where, Q : design drainage requirement (m^3/sec)

q : specific flood discharge of flooding obtained by Fig. 5.1.5 ($m^3/sec/km^2$)

A : drainage area (km^2)

5.1.3 Basic Design

(1) Irrigation plan

1) Irrigation system

Irrigation water will be drawn off by the intake weir to be provided on the Yongoma river about 1.5 km upstream from the Same-Tanga road. The right main canal will start from the intake structure to be provided on the right side of the weir and be diverted to the left main canal at the crossing point of the Same – Tanga road.

The right main canal will cover a service area of 242 ha with two (2) secondary canals. The left main canal to be diverted to two (2) secondary canals will cover a service area of 438 ha. The service area of each secondary canal will range from 81 ha to 354 ha.

Irrigation water will be diverted to the secondary canals and flow into each field through the tertiary canals and water courses. The service area commanded by each tertiary canal will range from 23 ha to 34 ha.

The irrigation flow diagram is shown in Fig. 5.1.6 and the following table shows the length and the net command area of each main and secondary canal.

Total Length, Net Command Area of Irrigation Canals

Irrigation Canal	Total Length (km)	Net Command Area (ha)	No. of Tertiary Canals (No.)
1. Right Main Canal	3.58	242	2
Secondary Canal			
RSC1*a	1.05	107	4
RSC2	0.65	81	3
2. Left Main Canal	1.26	438	0
Secondary Canal			
LSC1*b	2.55	354	11
LSC2	1.28	84	3

*a: RSC = Right Secondary Canal *b: LSC = Left Secondary Canal

2) Irrigation facilities

Yongoma head works

Gneissose rock will be exposed at the left bank of the proposed weir site and the right bank will be composed of boulder beds of the alluvial cone. The geological profile at the site, illustrated in Fig. 5.1.7, shows that the boulder beds of alluvial cone are buried under a thin layer of riverbed gravel and the total thickness of these beds is around 7 m. On the basis of this geologic profile, the fixed type weir is to be designed with a basic design for stabilizing the weir body and for cutting off infiltration flow below the weir body.

A scouring sluice gate will be provided on the right side of the weir and intake facilities will also be provided on the right side. The desilting basin, spillway and the measuring device will be provided just downstream of the intake facilities.

Main features of the headworks are summarized below:

i) Intake weir

- catchment area	:	70.5 km^2
- design flood discharge	:	149 m^3/sec (50-year return period)
- type	:	fixed type
- elevation of the crest of the weir	:	EL. 527.10
- design flood water level	:	EL. 529.02
- weir height×weir length	:	9.4 m × 25.0 m
- scouring sluice gate	:	2.5 m × 2.0 m, 1 No.

ii) Intake facility

- design intake discharge (Max.)	:	0.925 m^3/sec
- design intake water level	:	EL. 527.00
- intake gate	:	1.5 m × 1.0 m, 1 No.

iii) Desilting basin

- length×width	:	12.0 m × 3.0 m
- crest length of spillway	:	6.0 m
- wasteway gate	:	1.2 m × 0.7 m, 1 No.

iv) Measuring device

- type	:	Parshall flume

Irrigation canals

The canals leading to the tertiary canals from the Yongoma headworks will consist of right and left main canals and several secondary canals. As the tertiary canals and water courses will be constructed at the same time as on-farm development works, these canals will be included in the "on-farm" development work category. Main and secondary canals will be lined with the pre-cast concrete blocks to increase the conveyance efficiency of canals.

Basic design for the main and secondary canals is done in accordance with the following criteria.

- Design discharge

$$Q = q \times A$$

where, Q : design discharge (m^3/sec)

q : unit design water requirement

q = 1.36 ℓ/sec/ha for main canal

q = 1.61 ℓ/sec/ha for secondary canal

A : net command area (ha)

- Allowable maximum design velocity

Vmax. = 1.2 m/sec

- Allowable minimum design velocity

Vmin. = 0.3 m/sec

- Canal inside slope

Main canal : 1:1.25~1.0

Secondary canal : 1:1.0

- Roughness coefficient

n = 0.015

Main features of the main and secondary canals are as follows:

Main Features of Irrigation Canals

	Name of Canal	Design Discharge (m^3/sec)	Gradient	Base Width (m)	Canal Height (m)
1.	Right Main Canal	0.93~0.39	1/1000~1/3,000	0.30~0.60	0.75~1.20
	Secondary Canal				
	RSC1*a	0.17~0.09	1/200~1/3,000	0.30	0.50~0.75
	RSC2	0.13~0.09	1/1,000	0.30	0.50
2.	Left Main Canal	0.60	1/1,000	0.40	0.85
	Secondary Canal				
	LSC1*b	0.57~0.10	1/1,000	0.30~0.40	0.50~0.85
	LSC2	0.14~0.09	1/1,000	0.30	0.50

*a : RSC = Right Secondary Canal *b: LSC = Left Secondary Canal

Irrigation canal related structures

The following related structures will be provided in the irrigation canals for the diversion of water, crossing of roads and rivers and for maintaining the safety of canals.

- Turnouts

  Turnouts will be provided for the diversion of irrigation water from the parent canals to the other canals. Diversion water will be controlled by the turnout gate to be provided on this structure. Diversion discharge will be measured by reading the water level upstream of the turnout gate.

- Canals

  A check will be provided just downstream of the turnout to maintain the required water level during the period of partial flow in the canal. A sluice gate with manual operation will be provided on the structure for regulating the upstream water level.

- Spillway

  A spillway will be constructed in the canal system for the purpose of spilling out excess flow due to the malfunctioning of the check gates or intake gate and or the turnout gates. A wasteway will also be provided with the spillway to evacuate all water in the canal in case of an emergency and for canal maintenance purposes.

- Culverts

  Culverts will be constructed to convey the canal water under the roads. Box type or pipe type culverts will be provided in this project.

- Drops

  In order to bring about a mild canal gradient and to prevent high embankment of the canal, drops will be provided in the canal system taking topographic conditions and the situation of the turnout into consideration. Vertical drops will be applied in this project.

- Cross drains

Cross drains will be constructed across the irrigation canals at the places where the canals run across depressed lands or natural streams. Cross drains are classified into two types depending on the discharge design. One has a pipe barrel (min. dia. 600 mm) and the other has a rectangular-shaped concrete barrel.

- Measuring devices

In order to establish the effective use of irrigation water and reasonable water management, measuring devices will be provided on the canals at places where the main canals are diverted to the other main canals or secondary canals. A parshall flume will be applied in this project for measuring of the discharge.

- Aqueduct

An aqueduct will be provided on the left main canal for crossing of the Yongoma river. Since this aqueduct will be constructed in parallel with the bridge of the operation road, piers of the bridge will also be used for this aqueduct.

The required number of the above irrigation canal related structures are tabulated as follows:

Required Number of Irrigation Canal Related Structures

Irrigation Canal	Required Number of Structures (No.)							
	Turnout	Check	Spill-way	Culvert	Drop	Cross Drain	Measuring Device	Aqueduct
1. Right Main Canal (RMC)	5	3	1	5	5	3	1	0
Secondary Canal								
RSC1*a	4	2	1	1	0	0	1	0
RSC2	3	1	1	2	2	0	1	0
2. Left Main Canal (LMC)	2	0	1	1	3	0	1	1
Secondary Canal								
LSC1*b	11	5	1	5	0	0	1	0
LSC2	3	1	1	2	2	0	1	0
Total	28	12	6	16	12	3	6	0

*a : RSC = Right Secondary Canal *b : LSC = Left Secondary Canal

(2) Drainage plan

1) Drainage system

Since the river course of the Yongoma river is lost in the middle of the development area, river training work for the Yongoma river is required to drain any flooding of the river to outside of the development area. To drain flooding from the hinterland, catch drains will be provided around the outside of the area.

The drainage system in the development area will consist of main, secondary, tertiary and field drains. Excess water in the area will be drained through these canals out of the area.

The drainage flow diagram is shown in Fig. 5.1.3 and the following table shows the length and drainage area of the drainage canals:

Total Length and Drainage Area of Drainage Canals

Drainage Canals	Total Length (km)	Drainage Area (ha)	No. of Tertiary Drains
Yongoma Flood way Catch Drain (CD)	3.40	70.5km²	
CD - 1	4.10	1,306	0
CD - 2	5.60	750	0
Right Main Drain	0.66	361	0
Secondary Drain			
RSD1*a	1.92	203	5
RSD2	0.48	59	2
RSD3	0.66	35	2
Left Main Drain	2.98	545	2
Secondary Drain			
LSD1*b	1.92	184	5
LSD2	0.48	77	3
LSD3	1.14	67	2

*a: RSD = Right Secondary Drain *b: LSD = Left Secondary Drain

2) Yongoma floodway

It is planned that the floodway, which passes almost through the middle of the development area, is to be constructed as the river training works of the Yongoma river. The cross section of the floodway will consist of two portions. The basic design is carried out in accordance with the following criteria:

- Design flood discharge:

  121 m^3/sec (peak flood discharge of the Yongoma river within a 20-year return period)

  53 m^3/sec (peak flood discharge within a 2-year return period)

- Allowable maximum
  Water velocity : 2.0 m/sec

- Type : Earth canal (roughness coefficient, n = 0.03)

Taking into account economical construction, the design is carried out by using two kinds of flood discharge designs as follows:

- Ordinary discharge of the Yongoma river will be drained by the excavated canal designed using the peak flood discharge within a 2-year return period.

- On the other hand, flood dikes to be constructed along both sides of the excavated channel will be provided for protecting the development area against the peak flood discharge of the Yongoma river within a 20-year return period. These flood dikes will be constructed by using the excavated material of the channel and also be designed so as to have enough capacity to withstand the peak flood discharge within a 50-year return period, using the freeboard of dikes.

3) Catch drain

Flooding from the hinterland, which is the eastern slope of the South Pare Mountains, will be drained by using the catch drains to be provided at the places where the flood water flows into the development area. The catch drains are designed using the following criteria:

- Design discharge : $Q = q \times A$

where, Q : design flood discharge (m^3/sec)

q : specific discharge within a 2-year return period obtained from Fig. 5.1.5 (m^3/sec/km^2)

A : drainage area (km^2)

- Allowable maximum velocity : 2.0 m/sec

- Canal inside slope : 1:2.0

- Canal type : earth canal (roughness coefficient, n = 0.03)

To the design discharge of catch drain is applied the peak flood discharge within a 2-year return period. The main farm roads cum flood dikes to be constructed along the catch drains will prevent the development area from the peak flood discharge within 20 and 50-year return periods.

4) Drainage canal in the development area

The excess water from the development area to be collected by the field drains and tertiary drains will be drained through the main and secondary drainage canals.

The following criteria is taken for the design of main and secondary drainage canals:

- Design discharge : $Q = q \times A$

where, Q : design discharge (ℓ/sec)

q : unit drainage requirement within a 5-year return period as mentioned in the previous item 5.1.4(2).
q = 2.89 ℓ/sec/ha

A : drainage area (km^2)

- Allowable maximum velocity : 1.5 m/sec

- Canal inside slope : 1:1.5

- Canal type : earth canal
(roughness coefficient, n = 0.03)

Main features of drainage canals are summarized in the table below:

Main Features of Drainage Canals

	Name of Canal	Design Discharge (m^3/sec)	Gradient	Base Width (m)	Canal Height (m)
1.	Yongoma Floodway (Excavated Canal Portion)	53.0	1/300~1/650	30.0	1.0~1.2
2.	Catch Drain (CD)				
	CD - 1	13.36	1/300~1/600	2.00	1.50~1.80
	CD - 2	8.47	1/300~1/1,000	1.70~1.50	1.30~1.70
3.	Right Main Drain	0.36~2.10	1/2500	0.80	0.70
4.	Secondary Drain				
	RSD1*a	1.37~1.65	1/300~1/1000	0.80~1.00	0.80~1.00
	RSD2	0.17	1/1000	0.40	0.50
	RSD3	0.10	1/900	0.40	0.40
5.	Left Main Drain	0.62~2.17	1/500~1/5,000	0.80~1.20	0.70~1.50
6.	Secondary Drain				
	LSD1*b	0.81~1.13	1/300~1/500	0.80	0.60~0.80
	LSD2	0.22~0.33	1/350	0.40	0.40~0.50
	LSD3	0.19	1/2,000	0.40	0.60

*a: RSD = Right Secondary Drain *b: LSD = Left Secondary Drain

5) Drainage canal related structures

The following related structures will be provided in the drainage canals.

- Drops

Drops will be provided in the drainage canals with the same type and purpose as the ones for the irrigation canals. The large drops will be constructed by using gabions taking into account economical construction.

- Culverts

Pipe-type culverts or box-type culverts will be provided in the canals at the places where the canals will cross the farm roads.

- Bridge and footpaths

Several numbers of bridges and footpaths will be provided on the catch drains for access to the field from outside of the development area.

- Drainage gates

For the purpose of preventing the adverse flow of flood water from outside of the development area into the development area, drainage gates with a flap gate will be provided at the beginning point of the right and left main drains, respectively.

Required numbers of related structures are listed in the following table:

Required Number of Drainage Canal Related Structures

Name of Drainage Canal	Required Number of Related Structures				
	Drop	Culvert	Bridge	Footpath	Drainage Gate
1. Yongoma Floodway	0	0	0	0	0
2. Catch Drain (CD), CD - 1	2	0	2	2	0
CD - 2	3	0	1	2	0
3. Right Main Drain(RMD)	0	1	0	0	1
Secondary Drain					
RSD - 1	0	4	0	0	0
RSD - 2	0	1	0	0	0
RSD - 4	0	0	0	0	0
4. Left Main Drain(LMD)	0	4	0	0	1
Secondary Drain					
LSD - 1	0	4	0	0	0
LSD - 2	0	2	0	0	0
LSD - 4	0	2	0	0	0
Total	5	18	3	4	2

(3) Farm roads and flood dikes

1) System of farm roads and flood dikes

The main farm roads will be provided along the Yongoma floodway, main and secondary irrigation canals, and the east border and north border of the development area. These roads are to be constructed for the purpose of the operation and maintenance of the canals and truck transportation of farm products.

Branch farm roads will be provided along the tertiary canals for the same purposes as mentioned above. Field roads will be also provided along the water courses.

All the main farm roads surrounding the development area will have the function of flood dikes. The system of farm roads in the project area is figured in Fig. 5.1.9 and the total length of main farm roads is listed below:

Length of Main Farm Roads

Main Farm Roads (MR)	Length (km)
1. Right side	
MR1	3.58
MR2	3.08
MR3	3.97
MR4	1.62
Sub Total	12.25
2. Left Side	
MR5	1.20
MR6	3.02
MR7	3.15
MR8	2.31
MR9	5.77
Sub Total	15.45
Total	27.70

2) Main farm roads and flood dikes

Main farm roads and flood dikes are designed in accordance with the following criteria:

- The width of main farm roads will be 5.0 m taking, into consideration the width of the trucks.
- Main farm roads will be paved with morrum pavement using crushed weathered rocks or crushed pumice stones, with a pavement thickness of 15 cm.
- Minimum height of roads will be 50 cm on the original ground or field. However, roads along the irrigation canals will maintanance a road height more than the canal bed height.
- Outside slope of the road will be at 1:1.5.
- Minimum width for the top of a flood dike will be 2.5 m, and the outside slope of a dike will be 1:2.0.
- Top elevation of the flood dikes are to be decided taking the flood water level into consideration.

A road bridge will be provided at the place where the main road along the left main canal crosses the Yongoma river. Main features of this bridge are as shown below:

Type of bridge	:	Reinforced concrete bridge with T-beam
Total length	:	30 m
Bridge width	:	5 m
Number of spans	:	3
Bridge height	:	3.1 m

(4) <u>On-farm development</u>

For proper irrigation water distribution, the development area will be divided into number of irrigation blocks, which will cover fields of 23 ha to 34 ha and be served by one tertiary irrigation canal, drain and branch farm road. The irrigation block will be further divided into a number of farm plots. A typical farm plot is designed to have an acreage of 0.3 ha (30 m × 100 m) with at least one water

course, field drain and field road facing each farm plot. The typical farm layout is illustrated in Fig. 5.1.10.

The on-farm works will consist of tertiary canals, water courses, tertiary drains, field drains, branch roads, field roads and their related structures. The land levelling work for paddy fields and the construction of farm borders are also to be included in the on-farm work. The basic design for the on-farm works is done in accordance with the following criteria:

1) Standard farm plot : 30 m × 100 m (0.3 ha)

2) Irrigation canals (tertiary canals and water courses)

- Design discharge : A<30 ha, Q=48 ℓ/sec
  A≧30 ha, Q=64 ℓ/sec

  where, A : net command area
  Q : design discharge

- Canal type : earth canal
- Canal inside slope : 1:1.0
- Base width : 0.30 m

3) Drainage canals (tertiary drains and field drains)

Design discharge : $Q = q \times A$

where, Q : design discharge (ℓ/sec)
q : unit drainage requirement (2.89 ℓ/sec/ha)
A : drainage area (ha)

- Canal type : earth canal
- Canal inside slope : 1:1.5
- Base width : 0.40 m

4) Farm roads (branch farm roads and field roads)

- Road width	:	4.0 m, without pavement
- Outside slope	:	1:1.5
- Minimum road height	:	branch road 40 cm
		field road 30 cm

5) Related structures

- Diversion facilities

Two (2) types of diversion facilities are planned. One is a division box for diversion of irrigation water from the tertiary canal to the water course and the other is a farm outlet for diversion of the water from the water course to each farm plot. Both types are planned to be constructed by using pre-cast concrete material.

- Culverts

Pipe-type culverts will be provided in the tertiary canals and drains.

- Farm access

Farm access structures will be provided in the water courses for the passage of farm machinery across the canals.

- Drain pipes

Drain pipes will be installed in the field drains to drain excess water on each farm plot. This structure will consist of PVC pipe of 100 mm dia.

6) Land levelling work

Land levelling work is required to prepare fields suitable for irrigated paddy cropping. This work will be carried out aiming at a field whose finished surface is within the tolerance of ±7.5 cm of the designed surface level. Main features of on-farm works are tabulated as below:

Main Features of On-farm Works

Works		Name of Secondry Blocks					Total
		Right Main Canal			Left Main Canal		
		RMC*a	RSC-1*b	RSC-2	LSC-1*c	LSC-2	
1.	Area of Land Levelling (ha)	54	107	81	354	84	680
2.	Total Length of Irrigation Canals (km)						
	- Tertiary Canals	1.10	3.11	1.65	7.25	1.65	14.76
	- Water Courses	4.20	8.56	5.04	21.68	6.33	45.81
3.	Total Length of Drainage Canals (km)						
	- Tertiary Drains	1.10	2.42	1.10	7.26	1.10	12.98
	- Field Drains	3.36	6.78	4.20	17.99	4.98	37.31
4.	Total Length of Farm Roads (km)						
	- Branch Roads	1.32	4.57	2.64	9.89	2.53	20.95
	- Field Roads	4.80	9.82	5.76	24.74	7.17	52.29
5.	Related Structures						
	- Division Box (No.)	11	22	13	56	16	118
	- Farm outlet (No.)	80	158	106	450	125	925
	- Culverts (No.)	8	15	10	41	11	85
	- Farm Access (No.)	80	164	96	409	112	861
	- Drain Pipe (No.)	180	343	270	1,165	276	2,234

*a: RMC = Right Main Canal *b: RSC = Right Secondary Canal *c: LSC = Left Secondary Canal

5.2 Postharvest Facilities

5.2.1 Basic Concept

The basic design study for postharvest facilities is carried out in accordance with the following basic concepts.

1) Architectural plan

The buildings related to postharvest facilities will be composed of a drying house, rice mill house, multi-purpose warehouse, office and guard house. The architectural plans for these buildings are described in Section 5.4 together with the buildings related to the training facilities and O&M facilities.

2) Equipment Plan

In establishing the equipment plan, the following basic concepts are set up:

- All the equipment to be provided should have a simple structure for easy O&M such as periodical inspection and parts exchange.
- Running costs of the equipment should be low.

5.2.2 Determination of Basic Figures

(1) Crop production

1) Proposed cropping pattern

In the proposed cropping pattern, paddy cultivation is primarily proposed in the irrigation area both in the rainy season and dry season. While, maize and beans (maize mixed standing with beans) are proposed to be cultivated under rainfed conditions. The proposed cropping pattern is formulated in view of the climatic conditions of the area and soil moisture is to be controlled by irrigation water. The proposed cropping pattern is illustrated as shown in Fig. 5.2.1.

The cultivation area for each crop in the proposed cropping pattern is as follows:

Crop	Cultivation Area
Paddy (rainy season)	680 ha
(dry season)	230 ha
Total	910 ha
Maize and beans	450 ha

2) Crop yields and production

The prospective crop yields are estimated as follows:

Crop	Prospective Yield
Paddy (rainy season)	5.0 tons/ha
(dry season)	4.5 tons/ha
Maize	2.0 tons/ha
Beans	0.8 tons/ha

Based on the crop yields and cultivation areas estimated above, anticipated annual crop productions are estimated as follows:

Crop	Crop Production
Paddy (rainy season)	3,400 tons
(dry season)	1,035 tons
Total	4,435 tons
Maize	900 tons
Beans	360 tons

(2) Amount to be collected

The amount of crops to be collected by the marketing channel of the Cooperatives is estimated on the basis of the following assumptions:

- Farm population related to the development area is estimated to be 6,300 in the target year 1995 by applying an increase rate of 3% per annum to the present population of 4,850,

- Annual per capita consumption of crops is 80 kg for rice, 50 kg for maize and 30 kg for beans,

- Milling recovery rate from paddy to milled rice is 1 : 0.62, and

- Out of the production surplus, the amount to be collected by the Cooperatives is 80% for rice, 50% for maize and 0% for beans. The remaining amounts are to be used for consumption in and around the project area.

The results are shown in the table below. Amount of paddy to be collected is estimated at 2,550 tons which correspond to about 57.5% of its total production. Maize is estimated at 250 tons or about 28% of total production. While no collection to be expected for beans.

(Unit: tons)

		Paddy	Maize	Beans
Total production	(1)	4,435	900	360
Seeds and waste	(2)	440	90	35
Home consumption	(3)	810	315	190
Production surplus	(1)-(2)-(3)	3,185	495	135
Amount to be collected by the Cooperative		2,550	250	-

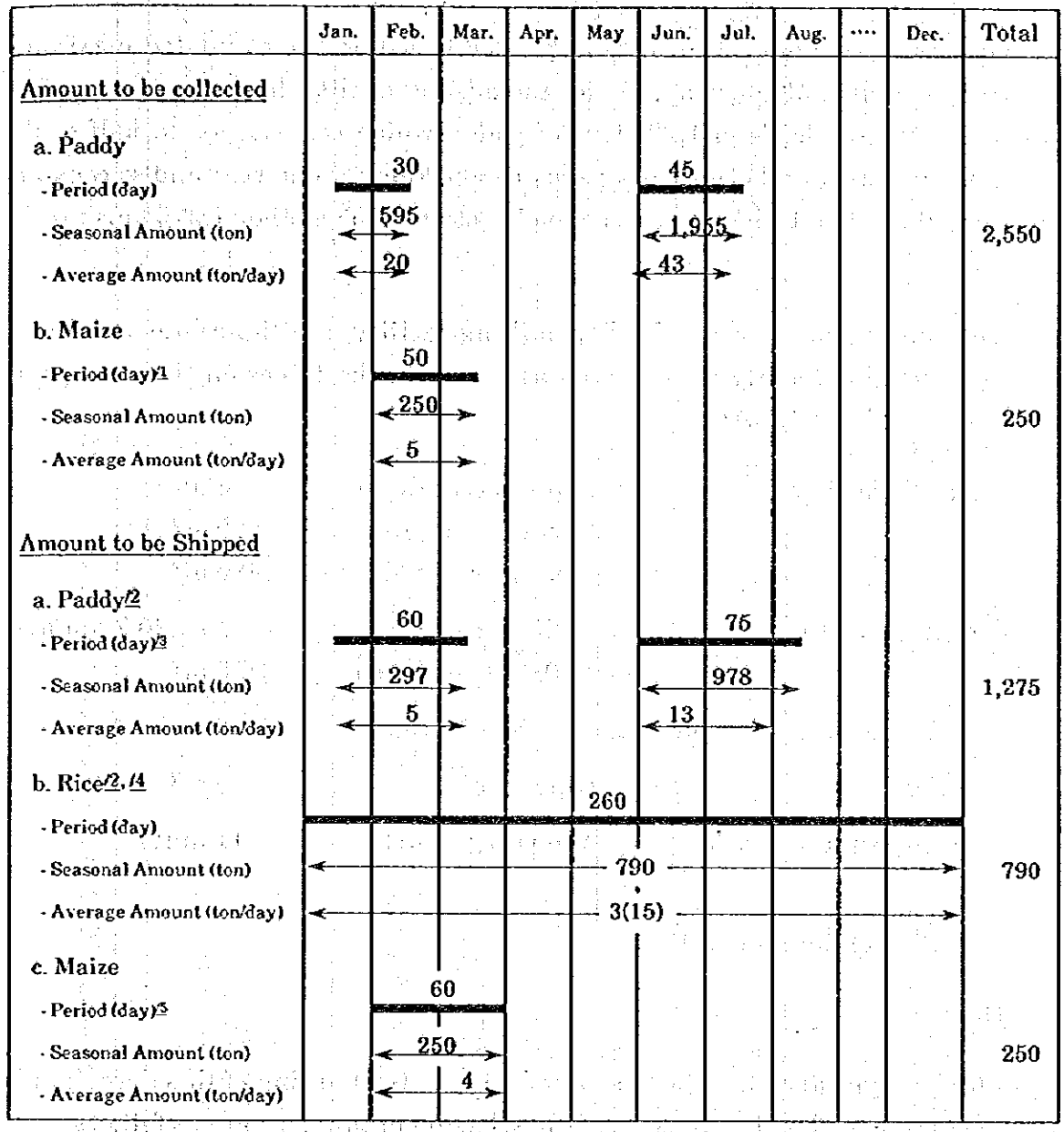
In the above table, all the figures for paddy show the tonnage estimated based on the total production from double cropping paddy. Therefore, for a further estimate of the amount to be collected from the respective cropping, the above mentioned percentage (57.5%) is applied both to the productions in the rainy season and in the dry season. As a result, the amount to be collected by the Cooperative from the respective croppings is as follows:

From rainy season production	:	1,955 tons
From dry season production	:	595 tons
Total	:	2,550 tons

(3) Seasonal amounts to be collected and to be shipped

Based on the amount to be collected and the proposed cropping pattern, seasonal amounts to be collected and to be shipped are estimated as shown in the figure on the next page.

SEASONAL COLLECTION AND SHIPPING AMOUNTS



Note: /1: Estimated amount to be collected is small at 250 tons for maize and its drying and transportation is expected to be handled by farmers themselves. For this work, it is estimated that 20 days will be required by the farmers. Therefore, 20 days are added to the harvesting period of 30 days and the period for maize collection is estimated to be 50 days in total.

/2: Amount of paddy to be shipped is all for NMC. While, rice is all sold out through VCU.

/3: It is estimated that 30 days will be required for drying and temporary storage both for rainy season paddy and dry season paddy.

/4: Paddy is expected to be processed constantly throughout the year, but the shipment for milled rice is expected to be made for 5 days' processing. Accordingly, average rice amount to be shipped is to be 15 tons.

/5: Ten (10) days of temporary storage are added to the period for collection.

5.2.3 Optimum Scale of Facilities

Optimum scale of each facility is decided based on the estimated maximum collection amount of 43 tons/day. As for the milling facility, however, the capacity is estimated on the basis of 1,275 tons of paddy which corresponds to half of the total collection amount, because dry paddy can be kept for one year and so constant operations throughout the year can be made possible. The other 1,275 tons are for NMC.

Optimum scale of drying facility, milling facility, multi-purpose warehouse and transportation facility is estimated as shown in the tables on the next pages and summarized as follows:

- Drying facility	:	Flat bed type dryer	6 units
		Drying house area	460 m^2
		Sun-drying yard area	480 m^2
- Milling facility	:	Milling machine	1 set (0.7 ton/hr)
		Milling house area	150 m^2
- Multi-purpose warehouse	:	Warehouse area	720 m^2
- Office	:	Office area	45 m^2
- Transportation truck	:	4-ton cargo truck	11 units

5.2.4 Outline of Equipment Plan

(1) Dryer

Flat bed type dryer has been selected. The rate of drying of this dryer can be expected to be 0.4%/hr. The reasons of the selection of this type are as follows:

- Standardized type is easy to procure,
- Maintenance is easy due to the simple structure, and
- Operation is easy and no skill is required

Because of its easy handling, the dryer with a holding capacity of 2 tons/dryer is considered to be adoptable. The required number of dryers is estimated at six (6) as mentioned in Section 5.2.3.

OPTIMUM SCALE OF POSTHARVEST FACILITIES (1/2)

Scale of Facility	Formula	Basic Data		Remarks
Drying Facility				
1. Required No. of Dryers : 6 units	Required processing amount/day ×Drying hrs+(24 hrs−Losses) +Holding capacity/unit	- Required proce. amount/day - Drying hours (Paddy moisture at reception−Paddy moisture after dryer)+Rate of drying/hr + 2hrs =(17%−14%)+0.4%+2** - Losses - Hold. capacity/unit***	: 26 tons* : 9.5 hr : 4 hrs : 2 tons	*: 1,955 tons ÷ 75 days = 26 tons **: 2 hrs for stuffing and taking ***: Flat bed type dryer (2 tons/unit)
2. Required Floor Area for Drying House = 459 m² (17×27m)				
(1) Dryers : 310 m²	Required floor area/unit×Required No. of dryers	- Required floor area/unit - Required No. of dryers	: 51 m² : 6 units	
(2) Wet Paddy Storage : 100 m²	(Required proce. amount/day÷Storage amount/m³÷Average stacking height)* +Floor area for passage,etc.	- Required proce. amount/day - Storage amount/m³ - Ave. stacking height - Floor for passage, etc.	: 26 tons : 0.5 ton : 1 m : 50 m²**	**: The same area as effective floor area (*).
(3) Dry Paddy Storage : 50 m²	2.(2) ×0.5*			*: 50% of total floor area of wet paddy storage.
3. Sun-drying Yard : 480 m² (15.5×15.5 m)×2	Required proce. amount/day +Bulk specific gravity +Thickness of paddy layer	- Required proce. amount/day - Bulk specific gravity - Thickness of paddy layer	: 13 tons* : 0.55 ton/m³ : 0.05 m	*: 50% of required processing amount/day of drying machine.
Milling Facilities				
1. Processing Capacity : 0.7 ton/hr	Required proce. amount/year +Operation hrs/year	- Required proc. amount/year - Operation hrs/year	: 1,275 tons* : 1,800 hrs	* To be operated constantly throughout a year (978+297 tons).
2. Required Floor Area for Milling House : 150 m² (75×20m)				
(1) Milling Machine* : 60 m²				*: Milling machine consists of cleaner, whitening machine, husker, etc.
(2) Dry Paddy Storage : 20 m²	(Milling capacity/hr×Milling hrs/day +Storage amount/m³÷Ave. stacking height)* +Floor area for passage, etc.	- Milling capacity/hr - Milling hrs/day - Storage amount/m³ - Ave. stacking height - Floor area for passage, etc.	: 0.7 ton : 7 hrs : 0.5 ton : 1 m : 10 m²**	*: Floor area for one day processing paddy. **: The same area as effective floor area.
(3) Rice Storage : 45 m²	(Rice production/day×5 days +Storage amount/m³÷Ave. stacking height)* +Floor area for passage, etc.	- Rice production/day - Storage amount/m³ - Ave. stacking height - Floor area for passage, etc.	: 3 tons : 0.7 ton : 1 m : 22 m²**	*: Floor area for 5 days rice storage **: The same area as effective floor area.
(4) Others* : 25 m²				*: Floor area for weighing, packing, etc.

OPTIMUM SCALE OF POSTHARVEST FACILITIES (2/2)

Scale of Facility	Formula	Basic Data	Remarks
Multi-purpose Warehouse : 720 m2 (15×48 m)			
1. Required Floor Area for Products			
(1) Max. Paddy Storage Amount for NMC : 383 tons	(Amount to be collected/day×0.5* −Amount to be shipped/day) ×Period for collection	- Amount to be collected/day : 43 tons - Amount to be shipped/day : 13 tons - Period for collection : 45 days	*: 50% of collected paddy will be shipped for NMC.
(2) Max. Paddy Storage Amount for Processing : 821 tons	Amount to be collected×0.5* −Average processing amount/day ×Period for collection×0.71***	- Amount to be collected : 1,955 tons - Average processing amount/day : 4.9 tons** - Period for collection : 45 days	*: 50% of collected paddy will be processed. **: (297+978 tons)÷260 days ***: 260÷365 days
(3) Required Floor Area : 645 m2 (15×43 m)	Max. storage amount÷Storage amount/m3 +Ave. stacking height +Floor area for passage, etc.	- Max. storage amount : 1,204 tons* - Storage amount/m3 : 0.5 ton - Ave. stacking height : 5.5 m - Floor area for passage, etc. : 205 m2	*: 383+821 tons
2. Required Floor Area for Farm Inputs : 75 m2 (15×5 m)	Required farm inputs/ha ×Cultivation area of rainy season paddy ×0.5*÷Storage amount/m3 +Ave. stacking height +Floor area for passage, etc.	- Required farm inputs/ha : 0.4 ton - Culti. area of rainy season paddy : 680 ha - Storage amount/m3 : 0.5 tons - Ave. stacking height : 5.5 m - Floor area for passage, etc. : 25 m2	*: 50% of required amount of farm inputs for rainy season paddy.
Transportation Truck : 11 units			
1. Required Nos. for Collection : 4 units	Amount to be collected/day ÷Loading capacity/truck ÷No. of round trips/day	- Amount to be collected/day : 43 tons - Loading capacity/truck : 4 tons - No. of round trips/day : 3 rounds	*: 4-ton cargo truck
2. Required Nos. for Shipping : 7 units*	Amount to be shipped/day ÷Loading capacity/truck ÷No. of round trips/day	- Amount to be shipped/day : 28 tons** - Loading capacity/truck : 4 tons - No. of round trips/day : 1 round	**: 13 tons of paddy+15 tons of rice

(2) Rice milling machines

The following complete set of rice milling machines (processing capacity of 0.7 ton/hr) will be installed.

- Paddy cleaner	:	Vibrating perforated screen type
- Destoner	:	Upward air blowing and gravity selection type
- Paddy husker with separator	:	Rubber-role type
- Rice whitening machine	:	Two-passing, abrasion and friction
- Bran collector	:	Cyclone type
- Fine broken rice separator	:	Vibrating perforated screen type
- Conveyer	:	Bucket elevator

The paddy cleaner and destoner are proposed to be attached to eliminate impurities for reduction of the burden of the paddy husker with separator. As for the rice whitening machine, two-way processing (abrasion and friction) is proposed aiming to increase the rice yield rate, because IRRI varieties to be introduced to the project area have medium to long grain and are easy to break. Though the connection between the machines are planned to be made by bucket elevators, other works such as raw material throwing in the machine and disposal of product are proposed to be done by hand.

Spare parts are to be provided for two years operation of the dryer and the rice milling machines.

(3) Transportation trucks

Widely useable medium-sized trucks are selected considering their usage both for collection and shipping (loading capacity of 4-ton cargo truck; 11 units).

(4) Others

In addition to the above mentioned equipment, platform scales (8 units), grain moisture meters (8 units), grain triers (5 units) and vinyl seats (size of 8x8 m; 8 units) are to be provided.

5.3 Training and O&M Facilities

5.3.1 Basic Concept

1) Architectural plan

The buildings related to the training and O&M facilities are as follows:

- O&M office (including training room)
- O&M dormitory
- O&M workshop

The architectural plans for these facilities are described in Section 5.4 together with those for the postharvest facilities.

2) Equipment plan

The selection of equipment and the determination of the required quantity are made in accordance with the following concept:

- The designs and technical specifications of equipment have to follow Japanese standards, because all the equipment to be provided is made in Japan,
- The equipment should be easily and economically operated and maintained. Complicated extremely high grade equipment should be avoided,
- The necessity of equipment should be carefully analyzed for O&M work that is required such as earthworks, repair work for related structures, communications, water management, etc., so that minimum requirements can be estimated, and
- Standard modes should be adopted, so that the parts will be easily obtained for future O&M works.

5.3.2 Optimum Scale of Buildings

The optimum scale of the buildings is basically determined in accordance with the activities and scope and the scale of work to be conducted on the proposed facilities. To figure out the optimum scale, relevant Japanese design manuals are referred to.

(1) Training room

The training room is proposed to be established within the O&M office aiming at smooth management and low construction costs.

Exact instructions for the farmers will be required on O&M of irrigation and drainage systems and farm management to obtain the anticipated results on the modernized farms to be constructed. The instruction will be carried out through block leaders and sub-leaders to be selected from the farmers' organization that is called the water users' group. Accordingly, the training room should have enough space for the assembly of these leaders.

In principle, one leader and three sub-leaders will be assigned for each block which commands an area of about 25 ha (see the figure of the farm layout). Therefore, the required space for the training room is estimated at 150 m^2 for 25 leaders and 75 sub-leaders in total.

(2) O&M office

The organization chart and required number of staff for O&M office is shown in Section 6.7. For such an organization and staffing, the building is designed as outlined below:

Room	Space (m^2)	Major Function	Complement
Manager's room	13.5	To be used also as reception room	1
Office room No. 1	60.0	For general office work	12
Office room No. 2	21.5	For Tanzanian exprrts	4
Meeting room	25.0	For small meetings	5
Training room	150.0	For farmers' training and communications	Refer to 5.3.2(1)
Storage room	23.5	For important instruments	
Lavatory	12.8		
Kitchen	4.8		
Copying room	5.76		
Others	43.16	Entrance hall, corridor, etc.	
Total	360.0		

(3) O&M dormitory

After the completion of the project, O&M for the irrigation and drainage system will be significant. For this reason, the staff to be assigned to the O&M office are expected to have long experience and distinguished technical skill. However, because of the technical staff shortage in the rural area in Tanzania, proper training for the site staff will be required to be made by experienced Tanzanian experts particularly for the schedule preparation for farming and for water management.

In the Ndungu area, there exist no appropriate lodging facilities for such experts, thus construciton of the following dormitory is proposed.

Room	No.	Space		
Bed room	8	16 m² × 8	=	128 m²
Dining kitchen	4	12 m² × 4	=	48 m²
Lavatory	4	3.84 m² × 4	=	15.36 m²
Corridor, etc.				52.8 m²
Total				244.16 m²

(4) O&M workshop

The machinery to be required for the O&M of the irrigation and drainage systems will be provided under this project. To carry out daily checking and maintenance work on such machinery, a workshop will be installed at the project site, though full-scale repairs will be covered by the workshop of RDD's office in Moshi city.

The proposed scale of the workshop is as follows:

Room	No.	Space
Workshop for machineries	1	80 m²
Storage room for parts	1	18 m²
Tool storage and office	1	18 m²
Total		116 m²

5.3.3 Outline of Equipment Plan

(1) O&M equipment

In accordance with the above mentioned basic concept, the following O&M equipment has been selected. For the equipment, spare parts will be provided for two (2) years' operation.

1) Equipment for repair work on the irrigation and drainage canal, farm road, etc.

- Bulldozer, 11 tons ..... 1 unit

The bulldozer will be introduced for general excavation and embankment work, pavement leveling and compacting work, etc. Small-sized 11-ton bulldozer will be applicable.

- Back hoe, 0.3 m^3 ..... 1 unit

The back hoe will be used for excavation work, particularly for the maintenance of drains and floodways of the Yongoma river. Small-sized 0.3 m^3 volume back hoe will be appropriate.

- Wheel loader, 0.8 m^3 ..... 1 unit

The wheel loader will work for the collection of embankment material to be applied for the repair work of canals and roads. Small-sized 0.8 m^3 volume wheel loader will be adoptable.

- Dump truck, 4 tons ..... 1 unit

The dump truck will be introduced for the transportation of embankment and road pavement materials to be used for repair work on canals and roads. Loading capacity of 4-ton will be applicable.

- Plate compactor, 3.0 Ps ..... 1 unit

The plate compactor will be required for repair work on the canals and roads, particularly for compaction of terminal canals and refilled soils of various structures. Small-sized 3.0 Ps plate compactor will be acceptable.

2) Equipment for repair work on related structures

- Concrete mixer with engine, 3.0 Ps ..... 1 unit

The concrete mixer is required for the repair work on related structures and canal linings. The capacity of 0.1 m^3 for kneaded concrete will be enough for this work.

- Cargo truck with 3-ton crane ..... 1 unit

A cargo truck with 3-ton crane to be used both for repair work on gates and the transportation of construction materials will be provided. Medium-sized 4-ton cargo truck will be applicable.

- Submergible pump with diesel generator, ϕ80 mm ..... 1 unit

The submergible pump will be required for removing water during repair work on drains and related structures. Medium-sized submergible pump, i.e. suction and exhaust diameter of 80 mm and maximum exhaust volume of 0.7 m^3/min will be adoptable.

3) Common equipment

- Pick-up truck (4-wheel drive) ..... 2 units

Pick-up trucks will be required for the transportation of construction materials to be used for small-scale repair work as well as for inspection of the irrigation and drainage systems, on-going repair work and farming work. One pick-up truck (one ton leading capacity) will be applied for O&M and for farm guidance, respectively.

- Station wagon (4-wheel drive) ..... 2 units

Station wagons will be used for communications purposes with RDD's office in Moshi city, DED's office in Same town and the authorities concerned in the said city and town. In addition, a station wagon will be required to give water management instruction to the personnel concerned. One station wagon will be arranged for water management and the other one will be for communications.

- Bicycle ..... 5 units

  Bicycles will be provided for the gate operation to be conducted by the gate-keepers.

The delivery of the above mentioned equipment and training on it for related personnel will be made according to the following manner:

- All the equipment will be carried to the Ndungu O&M office and assembled at the specified places. Then, it will be handed over together with the spare parts to the Government of Tanzania after giving it simple operational tests, and
- For the proper operation and maintenance of the equipment, their English operation manuals and parts lists will be provided.

(2) Repair tools for workshop

For the purposes of simple repairing and daily adjustment for the equipment to be provided, indispensable repair tools will be furnished as follows:

- Hand tools	:	1 set
- Measuring tools	:	1 set
- Electric tools	:	1 set
- Air equipment and tools	:	1 set
- Hydraulic and electric tools	:	1 set
- Welding equipment and tools	:	1 set
- Lubricating tools	:	1 set
- Engine service tools	:	1 set
- Tire service tools	:	1 set

(3) Equipment for training

The equipment for training to be required is as follows:

- Photo copy machine	:	1 unit
- Blue printing machine	:	1 unit
- Projector	:	1 unit
- White board	:	1 unit

5.4 Architectural Plan

5.4.1 Basic Concept

As already mentioned above, some buildings are required for the adequate processing of farm products and proper O&M work for the related facilities after completion of the project. Therefore, architectural plans should be established in due consideration of the future working flow, machinery arrangement and crop storage methods to be utilized in the respective buildings.

In the selection of the type of structure and utility of the buildings, habitual practices prevailing in Tanzania should be considered in view of easy and cheap maintenance. As for construction materials, items of Tanzanian manufacture should be adopted as far as possible. However, in general, the availability of construction materials in Tanzania's market is uncertain in quantity, variety and in availability. Therefore, such materials subjects to uncertain conditions are proposed to be all imported from Japan.

Grade of buildings

According to their structural characteristics, the buildings are divided into the following two (2) types:

Group A : Most of the buildings related to the postharvest facilities are classified into this group.

Steel structured buildings having relatively long spans and high eaves are proposed taking into account structural strength, durability and cost. Roofs and walls are to be covered with galvanized iron sheets.

Group B : Most of the O&M related buildings are classified into this group.

Reinforced concrete block structured wall and galvanized iron sheeted roof are proposed for these buildings, taking habitability and habitual practices into consideration.

For finishing work for the buildings both in Group A and B, durability and easy maintenance should be taken into account.

The assortment of the buildings mentioned above is summarized as follows:

Building	Group
- Drying house	A
- Sun-drying yard	*
- Rice mill house	A
- Multi-purpose warehouse	A
- Postharvest office	B
- Guard house	B
- O&M office (including training room)	B
- O&M workshop	A
- O&M dormitory	B

* concrete floor only

5.4.2 Optimum Scale

The proper scale of the buildings is estimated based on the size of the machinery to be installed, the number of staff and the labors to be carried out and their operational efficiency.

1) O&M buildings

Building/Room	Floor Area	Note
O&M office		
Training room	150 m²	100 persons × 1.5 m²
Manager's room	13.5 m²	
Office room No. 1	60 m²	12 staffs × 5.0 m²
Office room No.2	21.5 m²	4 staffs × 5.0 m²
Meeting room	25 m²	4 staffs × 5.0 m²
Lavatory, corridor, etc.	90 m²	
Total	360 m²	
O&M workshop		
Workshop for machineries	80 m²	Space for two (2) vehicles
Storage room for parts	18 m²	
Tool storage and office	18 m²	
Total	116 m²	
O&M dormitory		
Bed room	128 m²	16 m² × 8
Dining room	48 m²	12 m² × 4
Lavatory	15.36 m²	3.84 m² × 4
Corridor, etc.	52.8 m²	13.2 m² × 4
Total	244.16 m²	

2) Postharvest buildings

Building/Room	Floor Area	Note
Drying house		
Drying machine (6 units)	310 m²	51 m² × 6
Wet paddy storage	100 m²	
Dry paddy storage	50 m²	12 staffs x 5.0 m²
Total	460 m²	
Sun-drying yard	480 m²	15.5 m × 15.5 m × 2
Rice mill house		
Milling machine	60 m²	5 m × 12 m
Dry paddy storage	20 m²	
Rice storage	45 m²	
Others	25 m²	
Total	150 m²	
Multi-purpose warehouse		
Paddy storage for NMC	440 m²	383 t
Paddy storage for processing		821 t
Farm inputs storage	50 m²	
Passage, etc.	230 m²	
Total	720 m²	
Postharvest office		
Office	30 m²	6 staffs × 5 m²
Storage	6.0 m²	
Kitchen	4.5 m²	
Lavatory	4.5 m²	
Total	45 m²	
Guard house	12 m²	

5.4.3 Basic Design

(1) Building site

Ndungu village is located on a hilly area, which stretches in a north-east direction from the foot of the South Pare Mountains, located in the west of the project area and extends in a north-south direction. The Yongoma river flows from the mountains into the Kambaga river branching into three (3) streams.

Ndungu village is clustered on the east side of the Same - Tanga road running along the mountains. All the buildings are planned to be constructed on a

section of the sisal estate, which stretches on the west side of the Same-Tanga road. The area of the building site is estimated at 40,000 m^2.

(2) Layout planning

The buildings related to the postharvest facilities, i.e. drying house, rice mill house, multi-purpose warehouse, sun-drying yard, office and guard house will be constructed within the postharvest facilities' zone taking adequate working flow into account.

The O&M office building including the training room and the workshop for the repair of O&M machinery will be built in the O&M facilities' zone.

The dormitory with cooking facilities will be arranged in the dormitory zone for instructors to be dispatched from governmental organizations.

These zones will faced the public roads, so as to achieve convenient operation.

(3) Floor and storey planning

The buildings for the related facilities will be constructed separately each in consideration of the differences of the characteristics of the respective machineries to be installed, e.g. the degree of the occurrence of noise and dust. The distances between the buildings will be arranged adequately taking the work efficiency of vehicles into account. Floor planning will be arranged in due consideration of the functions to be given to the respective buildings.

Since machinery and heavy equipment are to be installed in these buildings, single storey is recommendable in view of its structural and operational advantage.

(4) Structural planning

A steel structure will be adopted for such raised buildings with long spans and high eaves as the plant and warehouse because of its surpassing strength, light weight and low cost. The foundation and the floor slab of these buildings will be reinforced concrete with structural expansion joints.

For general buildings such as office buildings and dormitories, a reinforced concrete block structure will be adopted according to habitual practices in

Tanzania. For the foundation, reinforced concrete continuous footing will be applied. The roof truss will be made of wood.

The allowable soil bearing capacity of 10 tons/m^2 is estimated to be adequate for the building site which is formed of sandy alluvial soil and has rather firm ground.

(5) Finishing work planning

Corrugated vinyl coated iron sheet, which has surpassing light weight, strength and durability, will be applied to the finishing work of the roofs and walls of steel-structured buildings. A concrete wainscot will be provided for the lower section of walls so as to prevent damage during construction. Openings with wire mesh will be provided on the upper part of the building's longitudinal walls for the sake of air supply, wind ventilaiton and lighting, and so the roof's overhang length will be long enough to prevent rain water blowing in.

A light weight steel shutter will be furnished to large openings such as loading doors. Windows for lighting will have an aluminum sash, glazed louver, insect screen and steel grille.

The buildings such as office buildings structured with reinforced concrete blocks will have a roof of corrugated vinyl coated iron sheets. As for the walls, emulsion paint will be additionally applied to the mortar-trowelled concrete wall.

An insect screen and steel grille will be furnished on the windows with glaze louver.s The room floor will have a terrazo grinding finish, and the room ceiling will have an oil paint finish after applying plywood.

(6) Power source planning

Commercial electricity is transmitted to Ndungu Village at 11 Kv, and is distributed to the villagers through the pole transformer located on the north of the building site.

The conductors of the buildings will be at 415 v/220 v, 50 Hz. The wiring for mechanical and lighting equipment in the respective buildings will be connected through the substation for electric power by overhead conductors. The lighting box in the plant and warehouse will be fixed lower than the general standard so as to save electricity. Based on this, the number of the lighting fixtures will be decided.

(7) Water supply system planning

The water for the buildings will be taken from the distribution pipe to be improved as a part of the project. The water service pipe with measuring meter for each building will be laid under the ground.

(8) Drainage system planning

Waste water from the lavatory and the kitchen will be conveyed to the catch basin, then discharged underground. The sewage will be discharged underground after purification in the septic tank to be made.

(9) Kitchen equipment planning

A kitchen sink and a cooking stove table will be equipped, and both propane gas and electricity will be used as heat sources for cooking.

5.5 Domestic Water Supply Facilities

5.5.1 Basic Concept

The existing facilities should be rehabilitated and utilized as effectively as possible. The water is drawn at the existing weir site and introduced to the grit-chamber, where the turbidity is considerably reduced. After that, the water is conveyed to public taps by gravity through distribution and service pipes. All the existing public taps are to be utilized. For the proposed extension area, public taps are newly to be installed with an interval of 300 m on the average.

5.5.2 Target Decision

(1) Target year

Population in the three villages was estimated at 9,000 in 1982 in the feasibility study report on the Mkomazi Valley Area Irrigation Development Project. In 1986, it is estimated to be about 10,000. The population has been increasing at an annual rate of about 3%. With the completion of the project, the increase of population would be accelerated. Taking the above into consideration, it would be adequate to settle the target year in 1995, namely five years after the completion of the project.

(2) Service population

The correct number of the present population in the three villages cannot be grasped because the census has not been carried out since 1978. The population in 1986 is estimated as shown below based on the information obtained from the Ndungu ward office.

Msufini Village	1,930
Ndungu Village	6,130
Kalimawe Village	2,020
Total Population	10,080

Water supply to Kalimawe Village would be excluded from the improvement plan. However, the population of Kalimawe Village would be taken into account in the estimation of future water demand. Population in the target year 1995 would be the basis of the improvement plan.

Population in 1995 is estimated by the following equation:

$$Y = Y_o (1+r)^x$$

where, Y : Estimated population after x years
Yo : Present population
x : Years to be passed up to target year (1995-1986=9)
r : Annual mean increase rate of population (3%)

Then $Y = 10,080 (1+0.03)^9$
$= 13,152$

Subsequently, the service population is determined to be 13,200 in total.

(3) Proposed service area

The existing water supply facilities cover almost all the area in Msufini Village and the eastern half area of Ndungu Village. No water supply facilities are installed in the western half area of Ndungu Village now. The future increase of population is expected in this western area of Ndungu Village. It is, therefore proposed that the future service area is settled so as to cover all the populated areas in both Msufini and Ndungu Villages.

The service area is divided into four blocks as shown in Fig. 5.5.1 and the present and future population in each respective block is assumed as shown below:

Population Distribution of Water Supply Blocks

Block	Present Population				Future Population		Remarks
	Area (ha)	Assumed Distribution Rate (%)	Population (head)	Density (head/ha)	Density (head/ha)	Population (head)	
Ndungu 1	54.5	60	3,680	68	75	4,100	P.W.S.A
Ndungu 2	39.5	30	1,840	47	66	2,600	P.F.E.A
Ndungu 3	41.5	10	610	15	46	1,900	P.F.E.A
Sub-total	135.5	100	6,130	45	-	8,600	
Msufini	26.0	-	1,930	74	75	1,950	P.W.S.A
Kalimawe	-	-	2,020	-	-	2,650	
Total			10,080			13,200	

Note: P.W.S.A means Present Water Supply Area
P.F.E.A means Proposed Facilities Extension Area

(4) Designed amount of water supply

According to the "Extracts of Water Supply Design Manual, Rural Water Engineers' Conference 1984" by the Government of Tanzania, the areas for the water supply project are classified into the following four categories and the guidelines for the required facilities are stipulated for each respective category.

- Rural Service Center
- Urban Service Center
- Municipal Service Center
- City Service Center

The project area is categorized as the rural service center. The proposed Project's facilities are planned following the above guidelines. The designed amount of water supply is estimated based upon the following daily mean supply amount per capita.

Water Consumption Standard Value per Capita per Day

Classification	Water Consumption (ℓ/capita/day)	Installation Rate in the Water Supply System (%)
Public tap	25	50
Low class household	70	25
Medium class household	130	20
Upper class household	200	5

Source: "Extracts of Water Supply Design Manual"

1) Daily mean supply amount per capita (q_1)

Daily mean supply amount per capita is calculated based on the above table as follows:

$$q_1 = 25 \times 0.5 + 70 \times 0.25 + 130 \times 0.2 + 200 \times 0.05$$
$$= 66 \text{ (ℓ/capita/day)}$$

2) Daily maximum supply amount per capita (q_2)

Daily maximum supply amount per capita is used to determine the capacity of the proposed facilities. Taking the leakage and seasonal fluctuations into account the daily maximum supply amount per capita is calculated as follows with the assumption that the load factor is 75%.

$$q_2 = q_1 \div \text{load factor}$$
$$= 66 \div 0.75$$
$$= 88 \text{ (ℓ/capita/day)}$$
$$\doteqdot 90 \text{ (ℓ/capita/day)}$$

3) Designed amount of water supply (Q_1)

Designed amount of water supply (Q_1) is calculated as follows by multiplying the daily maximum supply amount per capita (q_2) by the service population (N).

$$Q_1 = q_1 \times N$$
$$= 90 \text{ (ℓ/capita/day)} \times 13{,}200 \text{ (capita)}$$
$$= 1{,}188{,}000 \text{ (ℓ/day)}$$
$$\doteqdot 1{,}190 \text{ (m3/day)}$$

(5) Water quality

At present, the domestic water is taken from the Yongoma river and supplied to the service area without any treatment. Water quality tests were carried out during the course of the basic design study of this project and the Feasibility Study on the Mkomazi Valley Area Irrigation Development Project. The Yongoma river water clears the standard, except for its turbidity. The turbidity of the water is a little bit higher than the standards (Tanzania Temporary Standards for Rural Domestic Water Quality). However, it would be possible to reduce the turbidity within the standard by the installation of a grit-chamber. The results of these tests are summarized in Table 5.5.1, together with the standards.

5.5.3 Design of Facilities

The design of project facilities is to be planned so as that the existing facilities can be utilized to the maximum. Taking into account the field conditions, the newly proposed facilities are summarized below:

Center Measure for Facilities Design

Number of Facilities	Location	Availability for Use	Newly Installed Facilities	Countermeasure
Intake weir	Intake place	O		Intake pipe fixing and supporting
Grit-chamber	Near the intake		O	Type and dimensions designing
Distribution pipe	Each block	X		Hydraulic calculation for determination of pipe diameter
Service pipe	Block; Msufini & Ndungu 1	O		Connecting with distribution pipe
Service Pipe	Block: Ndungu 2&3		O	Calculation for determination of pipe diameter
Aqueduct	River cross point near intake weir		O	Type designing

(1) Design of distribution network

1) Proposed distribution network

The distribution pipe will be installed along the existing pipeline from the intake weir to the western part of Ndungu Village through the grid-chamber and Same-Tanga Road. The existing service pipe is to be

utilized as much as possible. For blocks No. 2 and No. 3 of Ndungu Village, the branch service pipe is newly installed.

All the service taps are to be constructed as public taps. The public taps are to be installed with an interval of approximately 300 m. The number of service taps and the amount of water supply per tap are summarized below. Proposed amount of water supply to Kalimawe Village is 4.14 (ℓ/sec).

Capacity of Proposed Public Taps

	Water Supply Population	Number of Public Taps			Water Supply Amount per Tap	
		Existing	New	Total	Population (head/tap)	Supply Amount (ℓ/sec)
Msufini	1,950	3	-	3	650	1.016
Ndungu 1	4,100	10	-	10	400	0.641
Ndungu 2	2,600	-	5	5	520	0.813
Ndungu 3	1,900	1	3	4	475	0.742

2) Hydraulic calculation

For determining the diameter of the distribution pipe, the maximum hourly supply amount is used. It is assumed to be 1.5 times the mean hourly supply amount based on actual results in Japan. For the hydraulic calculation of pipe, Harzen-Williams' Formula is applied as follows:

Harzen-Williams' Formula

$$I = 10.666 \times C^{-1.85} \times D^{-4.87} \times Q^{1.85}$$

where, I : Hydraulic gradient
C : Coefficient of velocity (including bend losses, C=110)
D : Inner diameter of pipe (m)
Q : Velocity (m^3/sec)

Friction loss is calculated as follows by multiplying the hydraulic gradient by the length of the pipe.

$$H = I \times L$$

where, H : Friction head loss (m)
I : Hydraulic gradient
L : Length of pipe (m)

According to the "Extracts of Water Supply Design Manual", the required minimum pressure at the turning point is the total amount of 5 m required head at the service tap and friction losses from the turning point to the service tap.

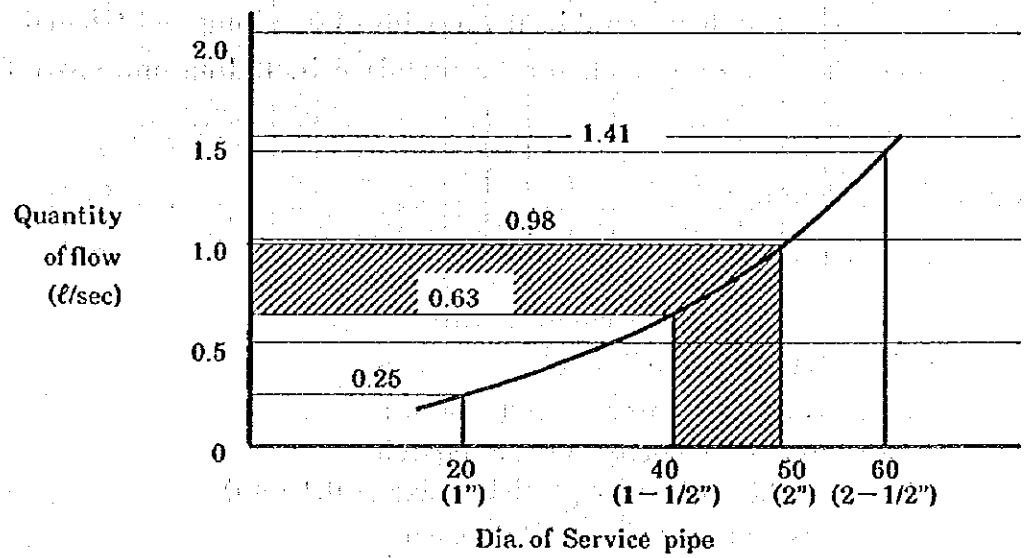
As seen Table 5.5.2, the design discharge of the newly installed service pipe is 0.6~0.8 ℓ/sec. Assuming that the mean flow velocity is 0.5 m/sec, the diameter of the pipe is known to be 50 mm (1.5") from the figure below. If the length of pipe is 200 m, the total friction loss is calculated to be about 2 m as follows:

$$I = 10.666 \times 110^{-1.85} \times 0.05^{-4.87} \times 0.000981^{1.85}$$
$$= 0.01025$$
$$H = 0.01025 \times 200$$
$$= 2.05 \text{ (m)}$$
$$\doteq 2.0 \text{ (m)}$$

Assuming that the total head loss of the service tap is 1.0 m, the required minimum head at the turning point is calculated as shown below:

$$H = 5.0 + 2.0 + 1.0$$
$$= 8.0 \text{ (m)}$$

Flow Capacity of Service Pipe (V = 0.5 m/sec)



With the conditions as above, the hydraulic calculations for the proposed facilities shown in Fig. 5.5.2 are summarized in Table 5.5.2.

3) Selection of the kind of pipe

The result of the hydraulic calculation shows that the required diameter of pipe is between 100 to 200 mm. On the other hand, the diameter of the existing pipeline is 50 to 100 mm. The existing pipeline is old and its flow capacity would be insufficient. All the existing pipeline should be replaced. Along the proposed route for the distribution pipeline, about 1,250 m reaching downstream of the intake weir is outrocked or covered with a thin topsoil. There is no suitable access road for the laying of the pipeline. It is, therefore, proposed that the open piping should be adopted for the above.

If open piping is applied, steel and cast-iron pipes are considered as the suitable pipes. Taking into account the easy construction and the anticorrosive nature of the material, ductile cast-iron pipe (T-type 3 class) is recommended as the most suitable kind of pipe. On the other hand, PVC water supply pipe is selected for underground piping sections with its economic advantage and easy construction.

(2) Grit-chamber

A grit-chamber is to be installed downstream of the intake weir in order to remove sand contained in the raw water. It is proposed to install the grit-chamber on the high land approximately 160 m downstream of the existing intake weir. The dimension of the grit-chamber would be 0.7 m wide, 4.0 m long and 0.5 m deep as calculated bellow. Two chambers should be installed including one spare for stand-by use.

- Length of grit-chamber

$$L = k\,(h/v) \times V$$

where,
- L : Length of grit-chamber (m)
- k : Safety factor (= 1.5)
- h : Effective water depth (= 50 m)
- v : Setting velocity of sand particle (= 0.8 cm/sec for particle's size as 0.1 mm)
- V : Mean flow velocity (4 cm/sec)

Then $L = 1.5 (50 \div 0.8) \times 4$

$= 375$ (cm)

$\doteq 4.0$ (m)

- Width of grit-chamber

$$W = Q \div (V \times h)$$

where, W : Width of grit-chamber (m)

Q : Supply amount of water (1,190 m^3/day = 0.0138 m^3/sec)

V : Mean flow velocity (4 cm/sec)

h : Effective water depth (= 50 m)

Then $W = 0.0138 \div (0.04 \times 0.50)$

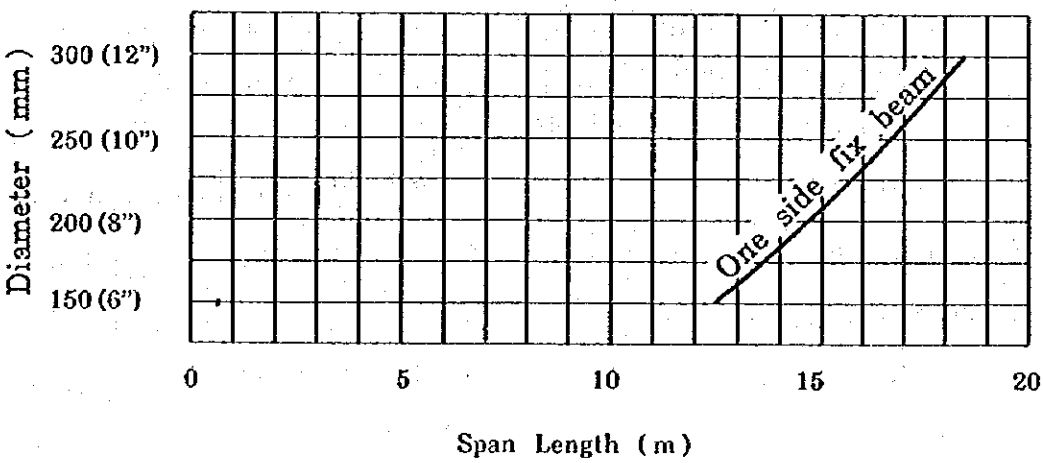
$= 0.69$ (m)

$\doteq 0.7$ (m)

(3) Aqueduct

At about 90 m downstream of the intake weir, one tributary about 10 m wide flows into the Yongoma River. In order that the proposed pipeline crosses the tributary, construction of an aqueduct is required. The aqueduct is proposed to be made of a steel pipe with a support of the one side fixed type. The diameter of the pipe is determined to be 200 mm based on the Figure below:

Allowable Span Length for Aqueduct



5.6 List of Equipment to be Procured

Item	No.	Specification
1. Postharvest equipment		
1) Flat bed type dryer	6	drying rate; 0.4%/hr, holding capacity; 2 tons/dryer, with burner, motor, fuel tank and thermometer
2) Rice milling machines	1 set	processing capacity; 0.7 tons/hr, connection between the machines is to be by bucket elevators.
- Paddy cleaner		vibrating perforated screen type
- Destoner		upward air blowing and gravity selection type
- Paddy husker with separator		rubber-role type
- Rice whitening machine		two-passing, abrasion and friction
- Bran collector		cyclone type
- Fine broken rice separator		vibrating perforated screen type
- Others		hopper, shoot, spare parts, etc.
3) Transportation truck	11	4-ton cargo truck
4) Others		
- platform scale	8	
- grain moisture meter	8	
- grain trier	5	
- vinyl sheet	8	8 m × 8 m
2. O&M equipment		
1) O&M equipment		
- Bulldozer	1	swamp-type, 11-ton
- Back hoe	1	0.3 m^3
- Cargo truck	1	loading capacity; 4-ton, with 3-ton crane
- Wheel loader	1	0.8 m^3

- Concrete mixer	1	0.1 m3, with engine
- Submergible pump	1	ϕ80 mm, with diesel generator
- Dump truck	1	loading capacity; 4-ton
- Pick-up truck	2	1-ton, 4-wheel drive
- Plate compactor	1	3 Ps
- Station wagon	2	4-wheel drive
- Bicycle	5	

2) Tools for workshop

- Hand tools	1 set	wrench, socket, handle, driver, etc.
- Measuring tools	1 set	tachometer, straight edge, magnetic base, etc.
- Electric tools	1 set	drill, grinder, wrench, sanding disk, etc.
- Air equipment and tools	1 set	air compressor, spray gun, air hose, etc.
- Hydraulic and electric tools	1 set	hydraulic test gauge, silicone charger, code reel, etc.
- Welding equipment and tools	1 set	welder, oxygen cylinder, acetylene cylinder, etc.
- Lubricating tools	1 set	torch lump, anvil, bench hydraulic press, etc.
- Engine service tools	1 set	volume pump, grease gun, etc.
- Tire service tools	1 set	tire pressure gauge, tire lever, jack, etc.

3. Equipment for training

- Photocopy machine	1 set
- Blue printing machine	1 set
- Projector	1 set
- White board	1 set

(Remarks) Spare parts for two (2) years will be procured as for 1. – 1), 2) and 3), and 2. – 1) out of the above equipment.

CHAPTER 6 EXECUTION OF THE PROJECT

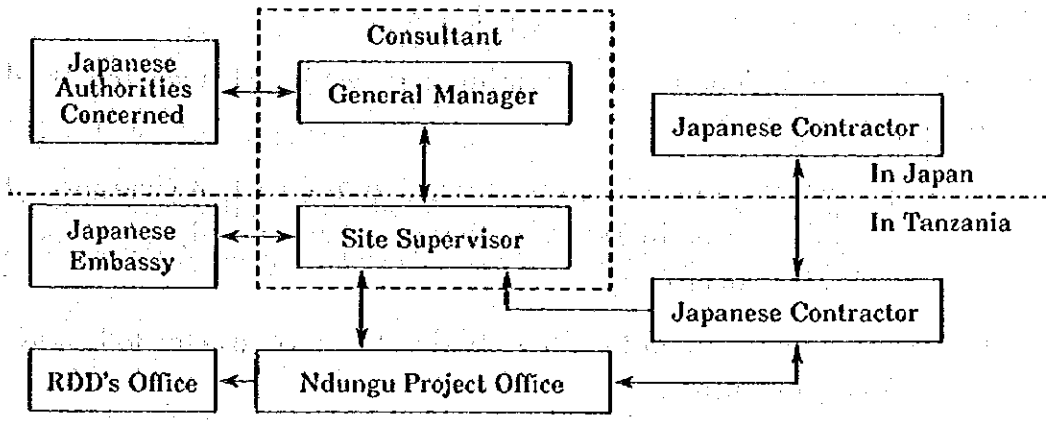
CHAPTER 6 EXECUTION OF THE PROJECT

6.1 Organization of Project Execution

The Kilimanjaro Regional Development Director's office, the Government of Tanzania will become the execution agency for the Project. The RDD's office will be authorized to execute the following work items for construction of the project:

i) Execution of all construction,
ii) Execution of contracts for consultancy services and for construction,
iii) Approval of design,
iv) Tendering and evaluation of tenders,
v) Approval of all payments,
vi) Administration of all contracts,
vii) Acceptance of completed works, and
viii) Liaison and coordination with other government agencies.

The representative of the Government will be the Regional Development Director (RDD). For the successful implementation of the project, it is proposed to establish an executing organization tentatively called the Ndungu Project Office. In order to coordinate, guide and assist the Project office during the implementation period, a Ndungu Agricultural Development Committee (tentative name) will also be organized under the RDD. The Committee will consist of representatives concerned such as a Regional Planning Officer, Regional Manpower Management Officer, Regional Accountant, Regional Irrigation Engineer, Regional Agr. & Live. Development Officer, District Executive Director and Village Chief. The proposed organization mentioned above is illustrated on page 96. The overall organization for the project execution is outlined as follows:



6.2 Scope of the Work

The scope of the Ndungu Agricultural Development Project to be covered under Japan's Grant Aid Program is outlined as follows (The details are shown in Chapter 5):

i) To construct irrigation and drainage facilities, farm roads and effect on-farm development for the development area of 680 ha in the Ndungu area,

ii) To construct the drying and milling facilities, storage facilities and their related buildings,

iii) To construct the O&M office of the project (including the farmer's training facilities) and lodging facilities,

iv) To improve the rural water supply system, and

v) To supply equipment and spare parts necessary for O&M of the project and for transportation of farm products.

While the major works to be taken by the Government of Tanzania are as follows:

i) To furnish data necessary for the detailed design,

ii) To secure the land for access roads, irrigation and drainage canals, and farm roads with relation to the project, and land allotment after completion of the construction,

iii) To secure, clear and reclaim the land for postharvest facilities and building facilities,

iv) To provide electricity distribution lines and a water supply system to the site mentioned above,

v) To bear commissions for the banking services based upon the Banking Arrangement,

vi) To ensure prompt unloading, tax exemption and custom clearance at the port of disembarcation in Tanzania for the required equipment, materials and vehicles for the project,

vii) To ensure tax exemption for the consultant and contractor to be engaged in the project execution,

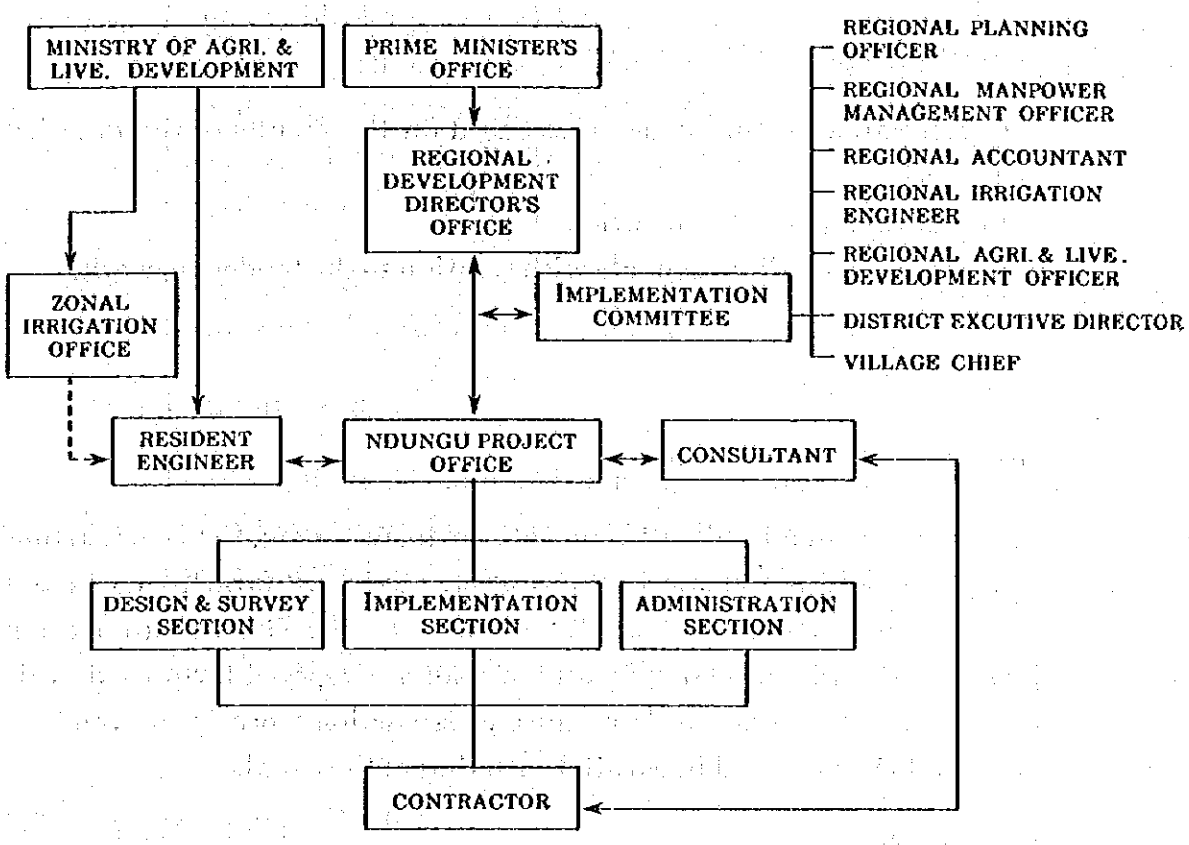
viii) To issue visa, traffic certificates and other certificates necessary for execution of the project to the consultant and contractor,

ix) To ensure payment of contract to consultant and contractor,

x) To bear the expenses to the required for proper and effective maintenance and use of the facilities and equipment after completion of the project, and

xi) To bear all the expenses other than those to be born by the grant aid necessary for the execution of the project.

Proposed Organization of Project Execution



6.3 Construction Plan

The project will be executed for the formation and scope of the works as stated in Section 6.2. An outline of construction methods and the schedule is described in this section.

6.3.1 Detailed Design

The following survey, detailed design and tendering works are necessary to execute the project before the start of the construction.

1) Topographic survey and other additional surveys

- Canal route centering survey based on the canal alignment prepared in this basic design, and establishment of the bench mark to be used for construction.
- Additional geological survey at the Yongoma headworks and the major facilities.

2) Detailed design and tendering work

- Confirmation of the project cost based on the results of the detailed design
- Preparation of tender drawings.
- Preparation of all documents with relation to the tendering work.

6.3.2 Construction Method

1) Access road for construction

The Same - Tanga road will be usable for transporting the construction equipment and materials to the project. Existing farm roads in the project area will be used as access roads for the Construction after giving minor repair and widening of roads. Proposed farm roads will also be used as access roads because construction work of the roads is planned to be executed in parallel with that of the canals.

2) Earth works

Earth works for the construction of irrigation and drainage canals, farm roads and on-farm facilities will be done basically by using heavy construction equipment. Stripping and excavation will be done by using the bulldozer or back hoe, and finishing will be done by hand. Embankments for canals and roads will be constructed in coordination

with the motor grader, bulldozer, dump truck, watering truck and several kinds of compactors.

3) Concrete work

Concrete work will be mainly required for the construction of the Yongoma headworks, concrete blocks for canal lining, several kinds of related structures and pre-cast concrete structures. Concrete will be produced by using the aggregate plant and the concrete plant provided near the project site. Concrete produced by the plant will be cast in each structure after transporting by the mixer truck.

Concrete blocks for canal lining, concrete pipes and pre-cast concrete structures will be constructed by the respective producing plant providing at the same concrete plant site. Those pre-cast materials will be carried by trucks or truck crane to the required site and set in accordance with the design.

Coarse and fine aggregates will be collected at the quarry site, about 2 km and 20 km far from the project area, respectively.

4) Building work

Land acquisition and land levelling work necessary for the construction of postharvesting facilities, the O&M office and other buildings will be the responsibility of the Government of Tanzania. The land acquisition and land levelling work should be completed before the construction. The site proposed for the land has been decided upon in the basic design period.

6.3.3 Construction Schedule

Construction of the Project is proposed to be divided into two (2) phases, in consideration of i) scale of the project work, ii) construction time, iii) maximum performance period under Japan's Grant Aid Program and iv) climatic and social conditions. Main components of the work to be taken in the respective phases are as shown below:

The first phase : Construction of headworks and right main canals, development of the area (242 ha) on the right side of the

Yongoma river and river training works for the Yongoma river.

The second phase : Construction of the left main canal, development of the area (438 ha) on the left of the river, improvement of the rural water supply system, construction of all buildings and Procurement of all the equipment.

6.4 Procurement and Transportation Plan

6.4.1 Procurement

It is planned that the construction materials are proposed to be procured in Tanzania as far as possible. However, materials which will cause difficulty in respect to the quality and marketability in Tanzania will be procured from Japan.

Main materials procurable in Tanzania are fuel and oil, electricity supply, cement, materials for road pavement, concrete blocks for buildings, aggregate materials, bricks and timber except plywood.

6.4.2 Transportation

Cargoes from Japan for this project will be landed at the Tanga port, from where the cargoes will be delivered on trucks or trains to the project site. Marine transportation of cargoes from Japan to Tanga takes one and half months. Taking into consideration the period required for procurement and loading in Japan, unloading and custom formalities at the Tanga port and inland transportation to the project site, the transportation period for cargoes from Japan to the site is estimated at three (3) months.

6.5 Detailed Design and Construction Supervision

6.5.1 Detailed Design and Tender & Contract

The consultant will conclude a consultancy service contract with the RDD, Government of Tanzania, immediately after the exchange of notes between the two Governments, and start detailed design following an execution plan agreed between the RDD and the consultant. The RDD will execute land acquisition and

levelling work, among other work to be carried out by the Government of Tanzania as mentioned in Section 6.2, to be in time for the start of construction. All detailed design work will be carried out at the consultant's head office in Japan after additional surveys at the project site. Detailed design have to be approved by the RDD before the tendering.

Advertising of tenders will be run in major papers in Japan in the name of the Government of Tanzania and tender documents will be distributed at the consultant's head office where they will be publicly opened by a representative of the Government of Tanzania. The consultant will thereafter assist the Government in evaluating tenders and drafting the contract.

6.5.2 Construction Supervision

After signing of the construction contract, the consultant's representative will go to the country to organize the start of construction. The consultant's chief engineer and irrigation & drainage engineer will be posted at the construction site during the whole period of construction and will supervise the construction on site. They will regularly report on construction progress and related matters to the concerned agencies of the Government of Tanzania as well as to the Embassy of Japan and JICA in Tanzania and coordinate all construction-related matters with the concerned officials of the project. In addition, the consultant will dispatch to the country several kinds of engineers for a short time to supervise the construction.

The consultant, on supervision services, will pay particular attention to Tanzania's natural surroundings, customs, traditions and capability of workers to effect smooth construction and completion of the work within the given period.

The construction program will be carefully scheduled taking into account the capability of the local workers and the period for delivery of construction materials and equipment to be imported from Japan.

The major activities to be carried out by the consultant's personnel are given below:

1) Assistance services in tendering and contracting

Assist in prequalification of tenderers, tendering, evaluation of tenders and drafting of contract.

2) Examination and approval of shop drawings

Inspect and examine and approve shop drawings, samples, catalogues, etc. and inspect equipment at the manufacturer's plant.

3) Inspection of construction work

See to it that construction complies with the contract in terms of schedule, construction methods and quality. Inspect and approve field work.

4) Approval of payments

Approve payment claims based on the progress of the work.

5) Reporting

Prepare regular progress reports on all matters concerning the construction for the information of the concerned agencies of the Tanzanian Government and Japanese Government.

6) Handing over of completed work

Hand over to the Government of Tanzania the completed work on examination of the work and on confirmation of fulfillment of all contractual obligations. Upon acceptance of the work by the Government, the consultant's project manager will be discharged.

6.6 Implementation Schedule

A tentative implementation time schedule including all those activities discussed above is illustrated on the following page.

Immediately after the agreement on the Exchange of Notes with respect to the construction in the first phase, the contract of the consultant will be carried out. The detailed design, preparation of tender documents, tendering, tender

evaluation and contract for execution will be executed for about 5.5 months. The construction of the project is planned to be completed during 13.5 months including the procurement period for construction materials and equipment.

As for the second phase, performance of work such as detail design, preparation of tender documents, tendering, tender evaluation and contract for execution will require about 4.0 months. The construction in the second phase will be completed during 14 months including the procurement of construction materials.

With regard to the construction, the Government of Tanzania will take responsibility for site reclamation, the extension of electricity and water to the related facilities and the construction of the gates and fences. The preliminary cost for these workes to be executed by the Governemnt of Tanzania is estimated at about Tsh. 1.5 million as shown below:

Cost to be undertaken by the Government of Tanzania

	Work Item	Amount (Tsh)
1.	Preparation of the Site for Buildings	
	- Clearing and grading	278,400
	- Land levelling	275,200
	Sub-total	553,600
2.	Installation of Electricity Distribution Line to the Site	500,000
3.	Construction of Barved Wire Fence around the Site	446,400
	Total	1,500,000

6.7 Operation and Maintenance Plan

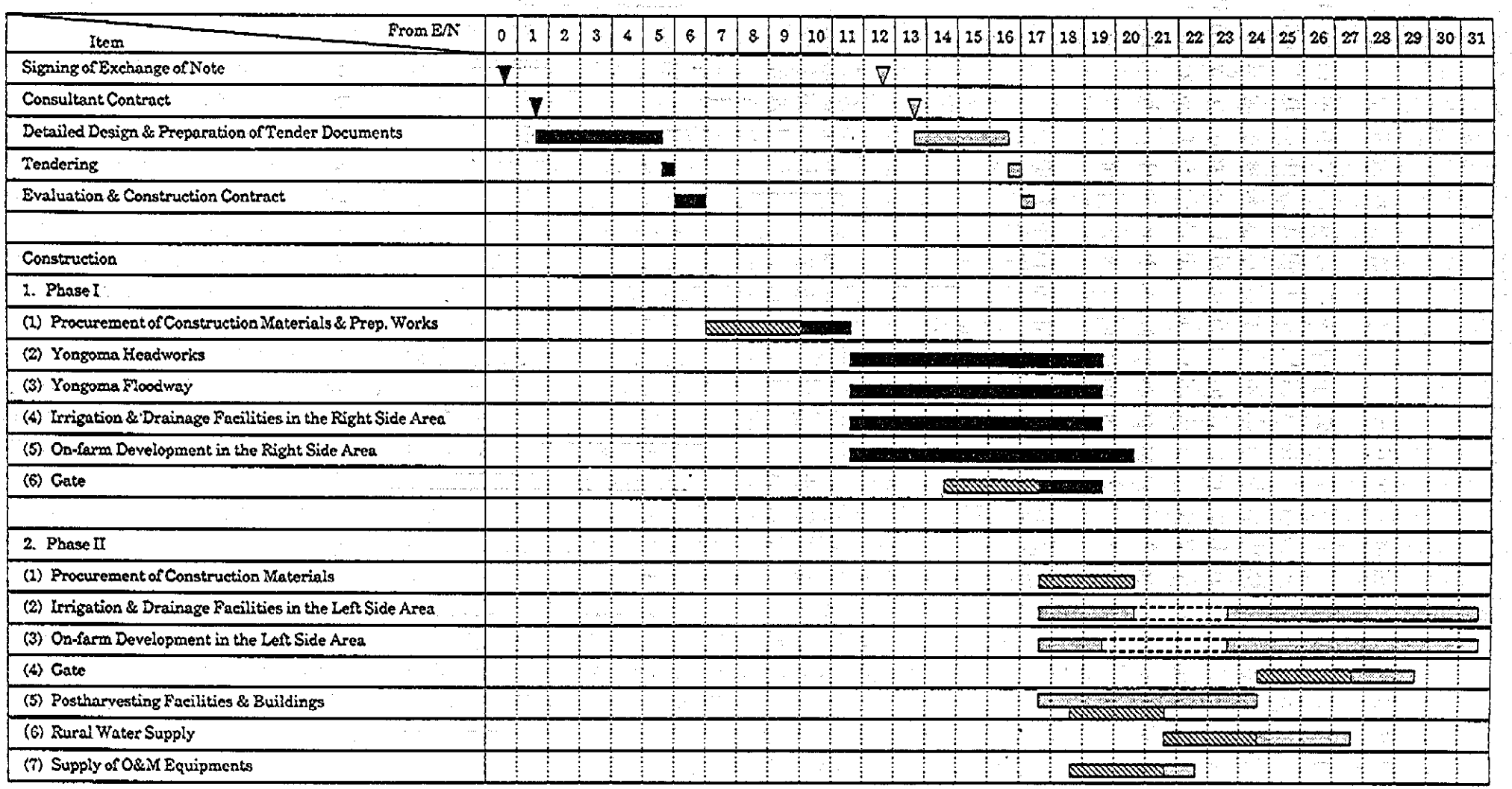
6.7.1 Organization

The RDD's office will be responsible for the O&M work of all facilities related to the project after completion of the construction. However, the practical O&M

work will be taken by the specific organizations under the control of the RDD's office as shown below:

Facilities	Overall Control	Organization in Charge
1. Irrigation & drainage facilities	RDD' office	O&M office for main and secondary canals and related structures, and farmers for on-farm facilities
2. Postharvest facilities	RDD' office	VCU
3. Training and meeting facilities	RDD' office	O&M office
4. Rural water supply facilities	RDD' office	DED's office, Same

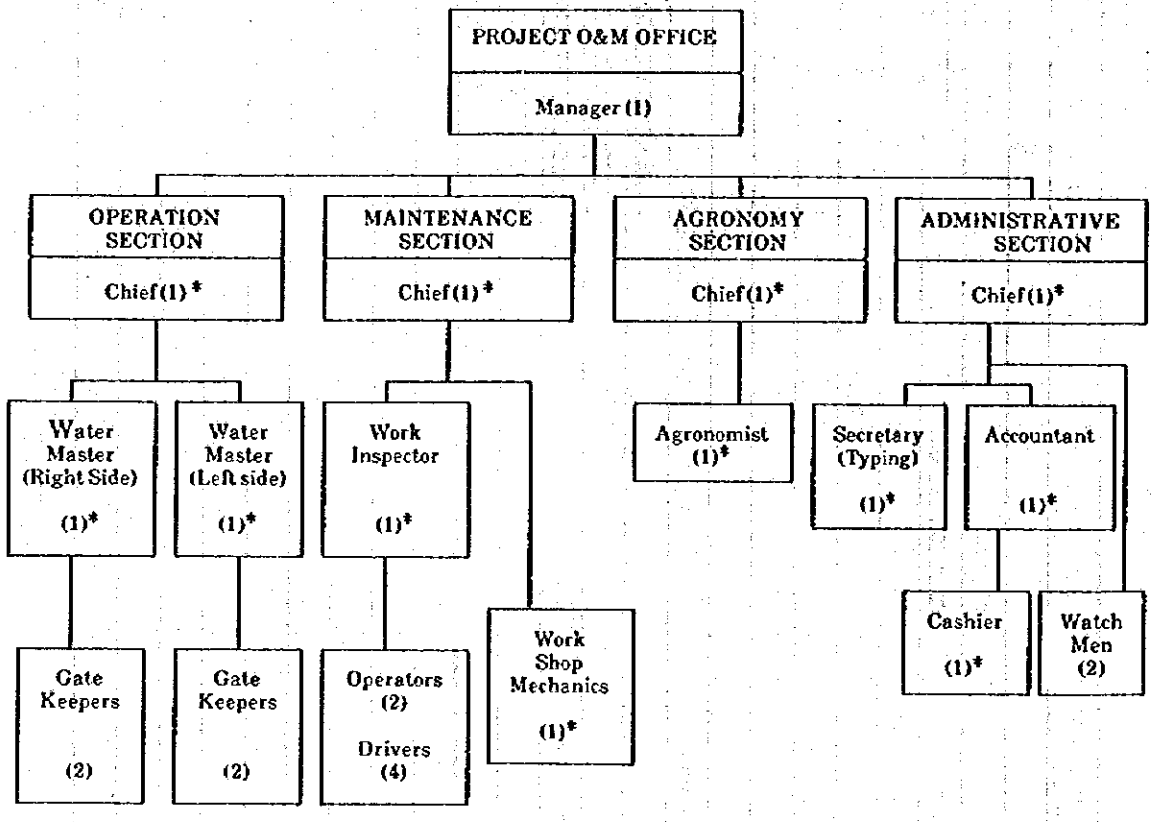
TENTATIVE IMPLEMENTATION SCHEDULE



1) Irrigation and drainage facilities

It is recommended that the Ndungu O&M office (tentative name) be newly established. This office will be controlled by the RDD's office. Aside from the O&M work for the irrigation and drainage facilities and the farmers' training center, this office will control the VUASU cooperative union (VCU), which will carry out the O&M work for the postharvest facilities. The proposed organization chart of this office is shown below:

Proposed Organization Chart of Ndungu O&M Office

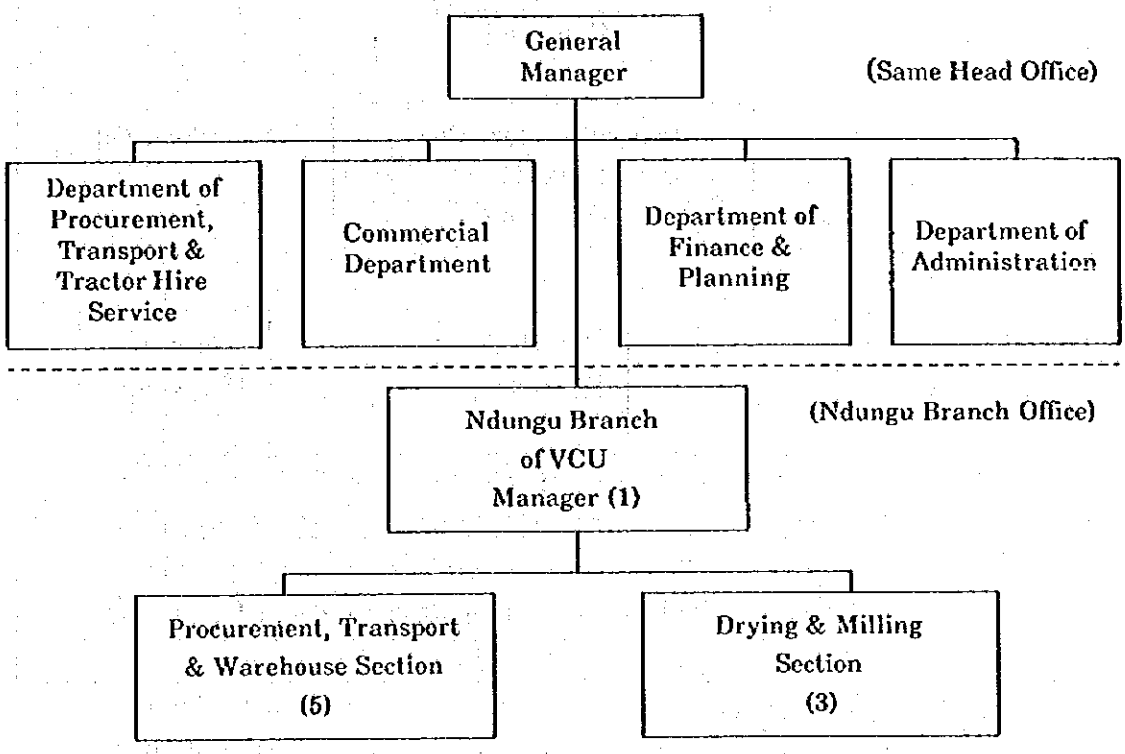


Note: Numbers in parentheses indicate the required personnel.

2) Postharvesting facilities

Postharvest facilities will be maintained and operated by the VCU, which will be controlled by the Ndungu O&M office, under the consignment contract between the VCU and RDD's office. Operation and maintenance costs for these facilities will be furnished by collecting the direct cost from the farmers who will utilize these facilities. Ndungu branch office of the VCU, therefore, should be established on the project site. The proposed organization chart is shown below:

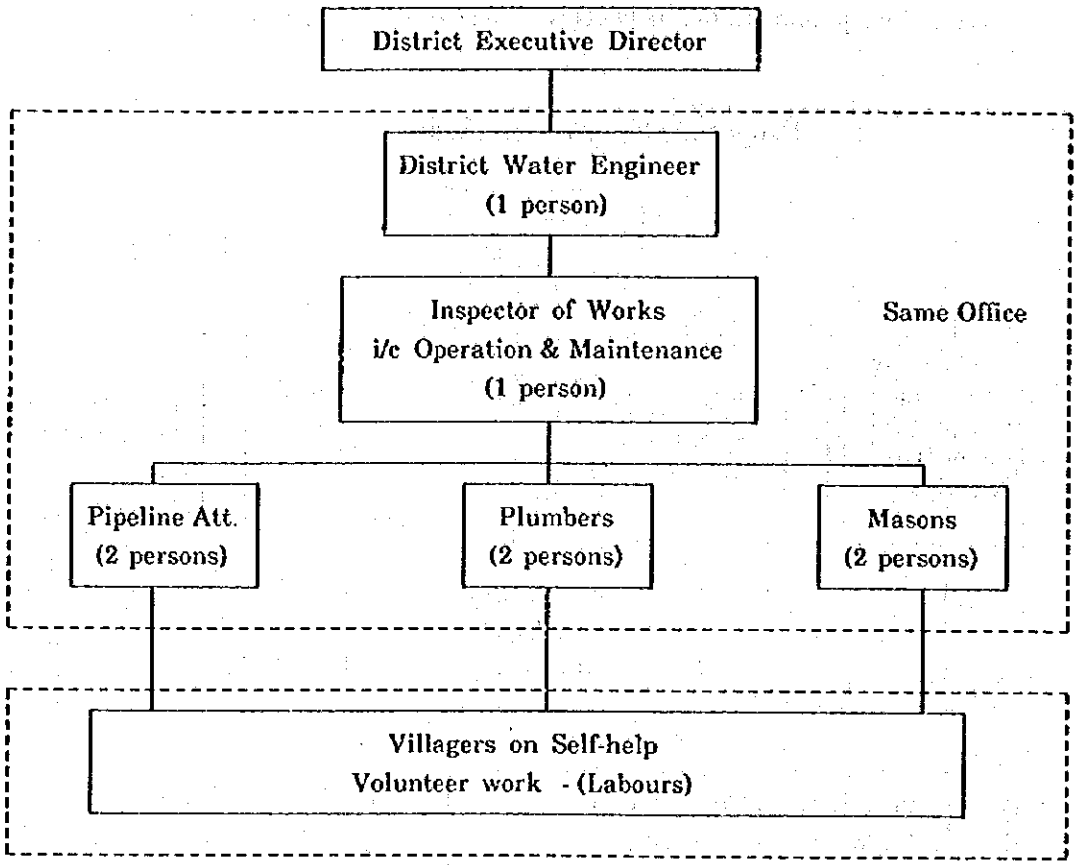
Proposed Organization Chart of VCU



Note: Numbers in parentheses indicate the required personnel.

3) Rural water supply facilities

Same as the present organization for O&M work of the rural water supply system in the Ndungu area, the improved facilities are also operated and maintained by the Department of Water Development, DED's office, Same under the control of RDD's office. The organization chart is shown as below:



6.7.2 O&M Cost

1) Irrigation and drainage facilities

The annual O&M cost of the Ndungu O&M office is estimated at about Tsh. 2,780 thousand as shown below:

Item	Cost (Tsh. $\times 10^3$/year)
1. Salaries	571
2. Office stationery	65
3. Office maintenance expenses (fuel and light, communications, etc.)	99
4. Labour charge	101
5. O&M cost of related equipment	1,812
6. Materials and others	132
Total	2,780

2) Postharvest facilities

All the responsibility for the O&M work for the postharvest facilities will be borne by VCU as already mentioned in the above Section. Therefore, O&M costs are also to be covered by VCU. The amount of paddy to be processed in these facilities is estimated at 2,550 tons/year. Out of this amount, half will be sent to NMC of a price of Tsh. 14,330/ton and the other half will be sold after milling directly to the market at the price of Tsh. 20,200/ton. The cost to be required for processing is estimated at Tsh. 940/ton for drying and Tsh. 1,540/ton for the milling. These costs will be fully covered by the margin difference between the buying (Tsh. 9,600/ton) and selling prices.

3) Rural water supply system

The O&M for the domestic water supply system will be the responsibility of DED's office, Same as is now the case. It is considered that present staff can cover all the necessary work for the O&M even under the conditions of the project. Although some increase in O&M

costs is expected due to the expanding of the service area, this cost will be covered by the water charge to be collected from the beneficiaries. Therefore, it is considered that no additional measures for the O&M works are necessary for the rural water supply system.

CHAPTER 7 PROJECT EVALUATION

CHAPTER 7 PROJECT EVALUATION

The project benefits to be expected from the implementation of the Ndungu Agricultural Development Project are: directly i) increase of agricultural production, ii) improvement of farming conditions, iii) improvement of rice quality, and iv) improvement of living conditions, and indirectly i) reinforcement of cooperatives, ii) demonstration effects and iii) improvement of social welfare.

1) Increase of farm production

Irrigated farming by traditional furrows is now practiced in the Nudungu area, though it is limited to 270 ha (27% of total farm land) in the rainy season and 140 ha (14%) in the dry season. Apart from this, all crop cultivation is practiced under rainfed conditions, and average crop yields remain extremely low.

After implementation of the project, crop cultivation is expected to become efficient and stable on farms equipped with the technical irrigation network, and paddy production is anticipated to reach 4,400 tons from the present production of 680 tons and maize to reach 900 tons from the present 500 tons. Consequently, the annaul gross farm income of the average farmer is expected to be increased to Tsh. 42,700 from the present figure of Tsh. 9,700. This increase of farm income will contribute toward the improvement of living standards of farmers in the project area.

Furthermore, as a result of the production increase, it is expected that about US$1.1 million per annum (converted into the CIF value of rice in 1984) will be saved, and Tanzania's food self-sufficiency rate, which is one of the most important targets of the national development plan, will be somewhat improved.

2) Improvement of farming conditions

With implementation of the project, farming conditions will be improved, and thus farmers' economic lives will be advanced by means of the farm roads to be constructed along irrigation canals.

3) Improvement of rice quality

By the construction of the rice processing facilites, the present rice processing situation in which a lot of broken rice is produced will be greatly improved, and so it will contribute to the improvement of rice quality and consequently to the amelioration of the farmers' income.

4) Improvement of living conditions

By the upgrading of the rural water supply system, living conditions, especially health and sanitary conditions in the area are expected to be greatly improved. Besides, by the construction of a training and meeting facility, which does not exist in the area at present, more functional village management will be conducted.

The following indirect project benefits can be expected in addition to the above described direct benefits.

1) Reinforcement of cooperatives

The Government of Tanzania puts stress on the promotion of the Cooperative Union/Cooperative Society system as one of its most important agricultural policies. In Kilimanjaro Region, two Cooperative Unions called KNCU and VCU were already established and had commenced their activities in 1984. The VCU, which has a head office in Same district, started such activities as the collecting and shipping of farm products. However, all the products are handled in the form of paddy, because there is no rice milling facility in VCU. Actual operation and management of postharvest facilities will be entrusted to VCU under RDD's control after the implementation of the project. Therefore, the financial situation and organizational activity of VCU is expected to be reinforced.

2) Demonstration effects

The Regional Government of Kilimanjaro is planning to start the Mkomazi Valley Area Irrigation Development Project following the ongoing Lower Moshi Agricultural Development Project. This Ndungu Project is to be implemented as the leading model scheme for

development of the whole Mkomazi Valley area, and is expected to provide various demonstration effects to the farmers in the valley area.

3) Improvement of social welfare

The purposes of the project are not only consolidation of agricultural production facilities, but also include improvement of social infrastructures such as domestic water supply facilities. Therefore the project is expected to greatly contribute to the improvement of living standards and social welfare, in addition to the increase of agricultural production.

CHAPTER 8 CONCLUSION AND RECOMMENDATION

CHAPTER 8 CONCLUSION AND RECOMMENDATION

As a result of the field survey in Tanzania and home analysis work in Japan, it became clear that very considerable direct and indirect project benefits can be expected from implementation of the Ndungu Agricultural Development Project as described in Chapter 7, and it is considered that the project will play an important and effective role not only in the agricultural and economic development in the Ndungu area, but also in the propulsion of Tanzania's National Development Plan. In addition, the Regional Government of Kilimanjaro identifies the project as a leading model scheme in expectation of future development of the Mkomazi Valley area.

It was confirmed that there is no organizational problem in RDD's office, which will take charge of the project implementation. An independent organizational system for project operation and maintenance is intended to be established under the control of RDD in parallel with the implementation of the Project, and consequently it is considered that there is no problem regarding the promotion of the project.

Considering the above mentioned situations, the request submitted by the Government of Tanzania is judged to be reasonable. It is concluded that implementation of the project, which is expected to play a leading role in the agricultural development of the Mkomazi Valley area and to have valuable impacts on the other development projects, is extremely significant, and that the scope of the project is favorable and appropriate for grant aid from the Government of Japan.

In order to realize the smooth implementation of the project and the adequate operation and maintenance of the project facilities, the following are recommended to the Government of Tanzania.

i) Immediate implementation and completion without delay of the construction work for which Tanzania will be responsible,

ii) Establishment of the organization for the construction work (e.g. construction office, management committee),

iii) Establishment of the O&M organization (Ndungu O&M Office, Water Users Group, etc.) for the project, arrangement of experienced staff and

preparation of all necessary facilities which are not covered by Japan's grant aid (e.g. staff accommodation),

iv) Preparation of an adequate budget for the above O&M organization, and training of the project staff,

v) Periodic checking and maintenance of the equipment and facilities, and

vi) Strengthening of the agricultural support system such as extension and training services, farm input supply services and tractor hire services.

TABLES AND FIGURES

Table 3.2.1 Summary of Land Classification (Land Suitability Appraisal of Major Soil Area)

Soil Sub-Group	Soil Family	Serial Soil No.	Appraisal in Suitability Classes	
			For Rice	For Upind Crops
Typic Ustifluvents	Sandy mineral soils	(1)	VIs	IIIs
Vertic Ustifluvents	Clayey, calcareous, and strong alkaline soils	(3)	IIId	VIad
Mollic Fluvaquents	Clayey, strong alkaline and low humic soils	(4)	IId	IVds
Typic Ustorthents	Loamy,strong alkaline soils associated with sandy and clayey soils	(6)	VIst	I
Typic Ustipsamments	Alkalline and mineral soils	(8)	VIsd	IVsd
Typic Tropaquents	Clayey and moderately strong alkaline soils	(9)	I	IId
	Clayey and moderately strong alkaline/saline soils	(10)	IIa	IIIad
Fluventic Ustropepts	Clayey mineral soils	(11)	I	I

Land capability has been evaluated in accordance with the USBR standard, as follows:

Class

Class I : Highly sitable for irrigated farming, without limitation.

Class II : Moderately suitable for irrigated farming, with moderate limitation due to coarse texture, rather steep slope, or impermeable sub-soil.

Class III : Rather suitable for irrigated farming, with limitation de to shallow soil, gravelly or stony soils or low fertility.

Class IV : Marginally or conditionally suitable for irrigated farming, with relatively serious limitation due to very shallow soil, steep slope or imperfect drainability.

Class VI : Unsuitable for irrigated farming, with serios limitations.

Sub-class

(s) : Soil textural qualities, limitation due to coarse texture with gravel for economic development of paddy field with irrigation facilities, and/or limitation due to very fine textre for upland crops with irrigation.

(k) : Effective soil depth, limitation due to sand, gravel, cobble, and/or rock formation and/or impenetrable sand layer within shallow depth below ground surface.

(a) : Soil salinity and alkalinity, limitation due to strong saline and alkaline reaction, high exchangeable sodium percent and/or sodim adsorption ratio of the soils.

(t) : Topography, limitation mainly due to unsuitable land elevation for economical gravity irrigation, and relief conditions unsuitable for economical field arrangement.

(d) : Drainage, limitation mainly due to the seasonal flooding or very poor internal drainability caused by high groundwater table and heavy clayey textre.

Table 5.1.1 Monthly Flow Discharge of Yongoma River

m^3/sec

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
1963	7.42	1.75	1.08	1.27	0.91	0.66	0.53	0.41	0.37	0.33	1.47	2.62
1964	2.64	1.39	2.65	1.73	1.50	0.94	0.67	0.51	0.41	0.43	0.44	2.28
1965	1.24	0.62	0.66	0.68	0.47	0.36	0.33	0.30	0.25	0.30	0.74	2.65
1966	1.11	1.20	1.38	1.43	0.86	0.69	0.54	0.40	0.32	0.33	0.60	0.94
1967	0.36	0.70	0.52	1.44	1.19	0.68	0.51	0.39	0.39	0.43	1.55	1.37
1968	0.61	0.50	2.39	2.50	1.38	1.04	0.73	0.56	0.44	0.46	0.93	2.75
1969	1.73	1.94	3.34	2.69	1.38	0.90	0.66	0.53	0.41	0.43	1.34	1.96
1970	1.59	2.04	2.66	2.85	1.53	0.95	0.69	0.54	0.44	0.33	1.10	1.78
1971	0.79	0.70	0.70	1.26	0.93	0.60	0.48	0.40	0.33	0.30	0.41	1.81
1972	1.53	0.95	0.85	0.77	0.95	0.59	0.45	0.37	0.36	0.33	0.96	2.27
1973	1.28	0.94	0.79	1.09	0.98	0.62	0.48	0.41	0.34	0.31	1.22	2.71
1974	1.10	0.75	0.83	1.36	1.17	0.73	0.57	0.48	0.38	0.37	0.83	2.64
1975	1.60	0.96	1.38	1.32	1.17	0.83	0.46	0.40	0.59	0.56	0.96	1.82
1976	1.33	1.07	1.37	2.20	1.22	0.91	0.72	0.66	0.61	0.61	0.54	0.75
1977	1.58	0.73	1.29	1.14	0.86	0.60	0.45	0.39	0.37	0.33	1.14	3.89
1978	3.21	2.02	3.93	3.38	1.80	1.20	1.12	1.12	0.94	0.81	3.18	8.53
1979	4.72	4.56	3.02	4.22	3.67	2.73	1.22	1.57	1.33	1.14	1.43	1.29
1980	0.88	0.79	0.76	1.12	0.80	0.58	0.47	0.41	0.64	0.26	1.09	2.34
1981	0.97	0.62	0.58	1.04	0.74	0.54	0.32	0.25	0.31	0.32	0.37	1.66
1982	1.62	0.80	0.74	1.40	1.00	0.93	0.67	0.60	0.62	1.11	2.52	3.52
1983	2.27	2.96	2.37	1.56	1.27	0.58	0.38	0.27	0.23	0.27	0.95	1.39
1984	0.75	1.36	1.48	1.70	1.79	1.47	1.02	0.74	0.62	1.07	2.67	4.26
1985	3.44	2.50	1.33	1.30	0.73	0.43	0.34	0.24	0.24	0.80	4.43	4.81
Ave.	1.90	1.34	1.53	1.68	1.19	0.81	0.56	0.49	0.45	0.48	1.35	2.61

Table 5.1.2 Climate at Kalimawe Meteo. Station

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Mean of Total	Period
Mean Max. Temp. (°C)	33.5	34.0	34.0	31.8	29.3	28.5	28.4	28.9	30.5	32.1	33.0	32.4	31.4	'68 - '86
Mean Min. Temp. (°C)	21.6	21.8	21.9	21.5	20.3	18.6	17.1	16.2	16.9	19.4	21.2	21.4	19.8	'68 - '86
Mean Temperature (°C)	27.2	27.8	27.9	26.6	24.8	23.6	22.6	22.6	24.0	25.8	27.0	27.0	25.6	'68 - '86
Min. Temperature (°C)	18.9	19.2	19.3	18.6	17.0	14.8	13.3	13.2	13.4	15.2	17.7	18.9	16.6	'71 - '86
Mean Max. Humid. (%)	75	73	77	78	79	74	76	80	77	78	75	76	77	'76 - '86
Mean Min. Humid. (%)	29	28	30	37	41	33	34	31	29	28	31	34	32	'76 - '86
Mean Humidity (%)	52	51	53	58	60	54	55	56	52	53	53	55	54	'76 - '86
Pan Evaporation (mm/day)	6.4	6.6	64	5.7	5.5	5.9	5.7	5.7	5.9	6.2	6.1	6.1	6.0	'64 - '86
Radiation (mm/day)	16.2	16.4	16.3	15.6	13.5	14.1	13.6	13.9	15.5	16.5	16.1	16.8	15.4	'67 - '86
Ran of Wind (km/day)	134	129	118	136	173	192	174	139	112	118	127	140	141	'67 - '86
Rainfall (mm)	62.0	45.7	71.9	70.8	26.7	4.5	2.0	4.7	8.4	18.4	58.0	90.1	463.2	'62 - '86
Rainy days (days)*	7.2 (6.6)	5.9 (5.5)	8.1 (7.5)	11.3 (10.4)	7.7 (6.9)	2.3 (1.9)	1.6 (1.4)	2.4 (1.9)	2.8 (2.5)	5.8 (5.1)	9.4 (8.8)	10.5 (9.8)	75.0 (68.3)	'62 - '86

* : Days having less than 0.1 mm (trace) are excluded.

Table 5.1.3 (1/2) Semi - Monthly Field Water Requirement

(UNIT : mm)

GROWING STAGE :	PLANTING YEAR 1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
AUG. 2 :	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
SEP. 1 :	12.	12.	12.	12.	1.	12.	12.	12.	12.	5.
SEP. 2 :	61.	61.	61.	61.	61.	61.	61.	61.	61.	61.
OCT. 1 :	117.	127.	120.	127.	104.	127.	110.	127.	127.	109.
OCT. 2 :	159.*	159.*	161.*	153.*	153.*	148.*	151.*	159.*	159.*	151.*
NOV. 1 :	82.	130.	89.	116.	121.	107.	80.	113.	130.	83.
NOV. 2 :	29.	131.	136.	131.	92.	76.	129.	136.	136.	97.
DEC. 1 :	92.	139.	64.	96.	116.	112.	139.	47.	139.	117.
DEC. 2 :	42.	135.	126.	130.	143.	143.	143.	109.	56.	101.
JAN. 1 :	39.	73.	85.	85.	85.	85.	29.	82.	74.	37.
JAN. 2 :	17.	17.	12.	17.	17.	17.	13.	13.	17.	16.

(UNIT : mm)

GROWING STAGE :	PLANTING YEAR 1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
AUG. 2 :	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
SEP. 1 :	12.	12.	5.	12.	12.	12.	9.	12.	12.	4.
SEP. 2 :	61.	61.	61.	33.	50.	61.	61.	61.	61.	61.
OCT. 1 :	122.	127.	127.	127.	119.	127.	127.	127.	100.	63.
OCT. 2 :	159.*	159.*	148.*	151.*	159.*	153.*	139.*	148.*	148.*	140.
NOV. 1 :	110.	130.	130.	130.	86.	120.	130.	88.	130.	130.
NOV. 2 :	136.	136.	136.	136.	83.	7.	128.	129.	127.	0.
DEC. 1 :	123.	126.	63.	139.	36.	0.	139.	116.	139.	39.
DEC. 2 :	128.	136.	143.	131.	96.	87.	82.	69.	77.	143.*
JAN. 1 :	85.	57.	81.	60.	85.	45.	78.	82.	80.	85.
JAN. 2 :	12.	17.	17.	17.	4.	17.	16.	17.	17.	17.

(UNIT : mm)

GROWING STAGE :	PLANTING YEAR 1983	1984	1985
AUG. 2 :	0.14	0.14	0.14
SEP. 1 :	8.	8.	8.
SEP. 2 :	61.	59.	59.
OCT. 1 :	130.	105.	107.
OCT. 2 :	160.*	150.*	157.*
NOV. 1 :	130.	29.	130.
NOV. 2 :	62.	98.	116.
DEC. 1 :	139.	127.	87.
DEC. 2 :	148.	123.	138.
JAN. 1 :	96.	92.	64.
JAN. 2 :	24.	27.	23.

NOTE; * MEANS MAXIMUM REQ. IN EACH PLANTING YEAR

Table 5.1.3 (2/2) Semi - Monthly Field Water Requirement

(UNIT : mm)

GROWING STAGE	PLANTING YEAR 1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
JAN. 1	0.17	0.	0.03	0.67	0.67	0.67	0.67	0.	0.34	0.
JAN. 2	0.	9.	9.	0.69	9.	9.	3.	0.	0.94	9.
FEB. 1	20.	25.	40.	17.	40.	40.	22.	29.	40.	17.
FEB. 2	62.	54.	80.	67.	80.	58.	80.	40.	74.	70.
MAR. 1	96.	62.	120.	99.	113.	92.	105.	120.*	103.	107.
MAR. 2	113.	84.	57.	18.	135.*	14.	86.	20.	100.	135.*
APR. 1	74.	90.	98.	108.	21.	41.	70.	98.	100.	115.
APR. 2	113.	69.	113.	113.*	21.	107.*	113.	90.	108.	90.
MAY 1	126.*	126.*	126.*	111.	108.	97.	126.*	118.	126.*	88.
MAY 2	81.	90.	82.	86.	72.	81.	90.	90.	90.	90.
JUN. 1	54.	54.	54.	51.	54.	50.	54.	50.	52.	54.
JUN. 2	17.	18.	18.	18.	18.	18.	18.	10.	18.	18.

(UNIT : mm)

GROWING STAGE	PLANTING YEAR 1973	1974	1975	1976	1977	1978	1979	1980	1981	1972
JAN. 1	0.67	0.67	0.	0.29	0.01	0.67	0.	0.35	0.67	0.67
JAN. 2	8.	4.	9.	6.	2.	0.	2.	0.	9.	9.
FEB. 1	40.	40.	40.	34.	40.	40.	19.	40.	40.	36.
FEB. 2	63.	80.	80.	75.	45.	59.	56.	77.	80.	57.
MAR. 1	114.	120.	111.	120.*	120.	40.	100.	99.*	120.	120.
MAR. 2	135.*	135.*	135.*	100.	119.	34.	110.*	126.*	35.	135.*
APR. 1	85.	115.	115.	104.	115.	78.	93.	93.	43.	75.
APR. 2	107.	3.	106.	46.	113.	71.*	108.	90.	83.	105.
MAY 1	81.	120.	117.	118.	126.*	119.	89.	120.	126.*	104.
MAY 2	90.	90.	86.	90.	90.	90.	72.	90.	83.	80.
JUN. 1	54.	54.	54.	54.	54.	51.	49.	54.	54.	54.
JUN. 2	18.	18.	18.	18.	18.	18.	18.	18.	18.	17.

(UNIT : mm)

GROWING STAGE	PLANTING YEAR 1983	1984	1985
JAN. 1	0.16	0.06	0.06
JAN. 2	1.	4.	5.
FEB. 1	30.	19.	22.
FEB. 2	54.	60.	52.
MAR. 1	82.*	88.*	88.*
MAR. 2	78.	76.	84.
APR. 1	72.	71.	70.
APR. 2	67.	18.	70.
MAY 1	78.	80.	58.
MAY 2	41.	39.	44.
JUN. 1	14.	15.	15.
JUN. 2	0.99	0.99	0.99

NOTE; * MEANS MAXIMUM REQ. IN EACH PLANTING YEAR

Table 5.1.4 Monthly Diversion Water Requiement

WET + DR Y

ℓ/sec/ha

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
1963	0.00	0.47	1.07	0.99	1.06	0.38	0.00	0.01	0.39	1.42	0.59	0.69
1964	0.33	0.45	0.75	0.84	1.11	0.38	0.00	0.01	0.39	1.47	1.39	1.41
1965	0.51	0.68	0.91	1.12	1.07	0.38	0.00	0.01	0.39	1.39	1.19	0.98
1966	0.50	0.48	0.60	1.17	1.01	0.37	0.00	0.01	0.39	1.44	1.31	1.16
1967	0.57	0.68	1.27	0.22	0.92	0.38	0.00	0.01	0.33	1.32	1.13	1.33
1968	0.57	0.54	0.54	0.79	0.91	0.36	0.00	0.01	0.39	1.41	1.50	1.31
1969	0.54	0.58	0.98	0.97	1.11	0.38	0.00	0.01	0.39	1.34	1.11	1.45
1970	0.22	0.39	0.72	1.00	1.07	0.38	0.00	0.01	0.39	1.47	1.32	1.31
1971	0.49	0.65	1.04	1.10	1.11	0.37	0.00	0.01	0.39	1.47	1.41	1.00
1972	0.51	0.48	1.24	1.09	0.91	0.38	0.00	0.01	0.35	1.34	0.96	1.12
1973	0.32	0.59	1.28	1.02	0.88	0.38	0.00	0.01	0.39	1.44	1.31	1.29
1974	0.52	0.68	1.31	0.63	1.11	0.38	0.00	0.01	0.39	1.47	1.41	1.35
1975	0.43	0.68	1.26	1.17	1.04	0.38	0.00	0.01	0.35	1.41	1.41	1.06
1976	0.54	0.60	1.13	0.80	1.07	0.38	0.00	0.01	0.24	1.43	1.41	1.39
1977	0.41	0.48	1.23	1.21	1.11	0.38	0.00	0.01	0.33	1.43	0.90	0.68
1978	0.46	0.56	0.38	0.79	1.07	0.37	0.00	0.01	0.39	1.44	0.67	0.45
1979	0.33	0.43	1.08	1.07	0.83	0.36	0.00	0.01	0.37	1.37	1.37	1.13
1980	0.48	0.64	1.16	0.97	1.08	0.38	0.00	0.01	0.39	1.41	1.15	1.46
1981	0.57	0.68	0.80	0.67	1.07	0.38	0.00	0.01	0.39	1.27	1.36	1.11
1982	0.55	0.53	1.31	0.96	0.94	0.38	0.00	0.01	0.34	1.04	0.69	0.93
1983	0.53	0.44	0.82	0.74	0.53	0.08	0.00	0.00	0.31	1.49	1.00	1.47
1984	0.64	0.43	0.84	0.47	0.53	0.08	0.00	0.00	0.36	1.31	0.67	1.28
1985	0.64	0.42	0.88	0.74	0.45	0.08	0.00	0.00	0.36	1.36	1.30	1.16
Ave	0.46	0.55	0.98	0.89	0.96	0.34	0.00	0.01	0.36	1.39	1.16	1.15

Table 5.1.5 Result of Water Balance Calculation
(Rainy Season Paddy 680ha, Dry Season Paddy 230ha)

m³/sec

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
1963	7.33	1.43	0.35	0.60	0.19	0.40	0.53	0.41	0.28	0.00	1.33	2.46
1964	2.54	1.08	2.14	1.16	0.75	0.68	0.67	0.51	0.32	0.09	0.12	1.96
1965	1.10	0.16	0.04	-0.08	-0.26	0.10	0.33	0.30	0.16	-0.02	0.47	2.43
1966	0.99	0.88	0.97	0.63	0.17	0.44	0.54	0.40	0.23	0.00	0.30	0.67
1967	0.21	0.24	-0.35	1.29	0.56	0.42	0.51	0.39	0.31	0.13	1.29	1.06
1968	0.46	0.13	2.02	1.97	0.76	0.79	0.73	0.56	0.35	0.14	0.58	2.45
1969	1.60	1.55	2.67	2.03	0.63	0.64	0.66	0.53	0.32	0.12	1.08	1.63
1970	1.54	1.77	2.17	2.17	0.80	0.69	0.69	0.54	0.35	-0.01	0.80	1.48
1971	0.67	0.26	-0.01	0.51	0.18	0.35	0.48	0.40	0.24	-0.04	0.09	1.58
1972	1.39	0.63	0.00	0.03	0.33	0.33	0.45	0.37	0.28	0.02	0.74	2.01
1973	1.19	0.54	-0.08	0.40	0.38	0.36	0.48	0.41	0.25	-0.02	0.92	2.41
1974	0.97	0.29	-0.06	0.93	0.42	0.47	0.57	0.48	0.29	0.03	0.51	2.33
1975	1.48	0.50	0.52	0.52	0.46	0.57	0.46	0.40	0.51	0.24	0.64	1.58
1976	1.19	0.66	0.60	1.66	0.49	0.65	0.72	0.66	0.56	0.28	0.22	0.43
1977	1.48	0.40	0.46	0.32	0.11	0.34	0.45	0.39	0.29	0.00	0.93	3.73
1978	3.10	1.64	3.67	2.84	1.07	0.95	1.12	1.12	0.85	0.48	3.02	8.43
1979	4.64	4.27	2.29	3.49	3.11	2.49	1.22	1.57	1.24	0.83	1.12	1.03
1980	0.77	0.35	-0.03	0.46	0.07	0.32	0.47	0.41	0.55	-0.06	0.83	2.00
1981	0.82	0.16	0.04	0.59	0.01	0.28	0.32	0.25	0.22	0.03	0.06	1.40
1982	1.47	0.44	-0.15	0.75	0.36	0.67	0.67	0.60	0.54	0.87	2.36	3.31
1983	2.15	2.66	1.81	1.06	0.91	0.53	0.38	0.27	0.16	-0.07	0.72	1.05
1984	0.59	1.07	0.91	1.38	1.43	1.41	1.02	0.74	0.54	0.77	2.51	3.96
1985	3.28	2.22	0.73	0.79	0.43	0.37	0.34	0.24	0.16	0.49	4.13	4.54

Table 5.1.6 Annual Maximum Basin Rainfall and Probable Basin Rainfall
(Yongoma River)

Annual Maximum Basin Rainfall

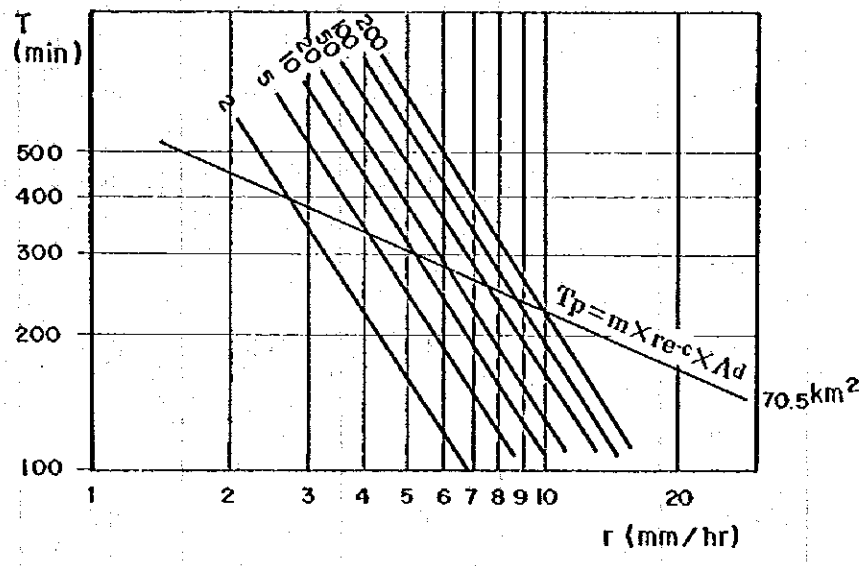
Year	1972	1973	1974	1975	1976	1977	1978	1979
Rainfall (mm/day)	72.8	41.7	34.1	31.5	46.6	59.5	88.6	69.6
Year	1980	1981	1982	1983	1984	1985	1986	
Rainfall (mm/day)	72.5	63.2	59.3	102.0	53.9	35.3	38.7	

Probable Basin Rainfall

Return Period in Year	2	5	10	20	50	100	200
Rainfall (mm/day)	55	74	87	97	114	126	138

Table 5.1.7 Peek Flood Discharge of Yongoma River

t(hr)	(mm/hr)	Return Period in Year 2	5	10	20	50	100	200
2	rt =	12	16.2	19.0	21.2	24.9	27.5	30.1
5	rt =	6.5	8.8	10.3	11.5	13.5	14.9	16.4
2	re·t =	6.0	8.1	9.5	10.6	12.5	13.8	15.1
5	re·t =	3.3	4.4	5.2	5.8	6.8	7.5	8.2



70.5 km²	Return Period in Year 2	5	10	20	50	100	200
re(mm/hr)	2.7	4.1	5.2	6.2	7.6	8.8	10
Tp(min)	400	330	300	280	255	240	225
Qp(m³/sec)	53	80	102	121	149	172	196

Table 5.5.1 Result of Water Quality Tests

Item	Unit	Results			Tanzania's guideline	WHO's guideline
		at B/D	at F/S			
Test Date		Dec. 20, '86	Dec. 29, '82	Jun. 19, '83		
Turbidity	ppm	41	–	–	30	5
P H		7.2			6.5~9.2	7.0~8.5
DissolvedOxygen	ppm	0.3	–	–	–	–
Dissolved Solids	ppm	–	15.5	–	–	–
$KMnO_4$	ppm	–	0.20	0.40	20	(10)
Ca^{2+}	ppm	–	2.5	9.5	300	75
Mg^{2+}	ppm	–	1.1	5.4	800	50
Cl^-	ppm	–	3.9	4.1	–	200
SO_4^{2-}	ppm	–	2.6	4.3	600	200
Fe^{2+}, Fe^{3+}	ppm	–	0.46	–	1.0	0.3
Mn^{2+}	ppm	–	0	–	0.5	0.1
Micro Organisms	per 1 cc	38	–	–	–	100
Califorms	per 100 ml	not detected	–	–	–	not detected
Electric conductivity	μΩ/cm	400	33.4	45.8	–	≧ [1,000]

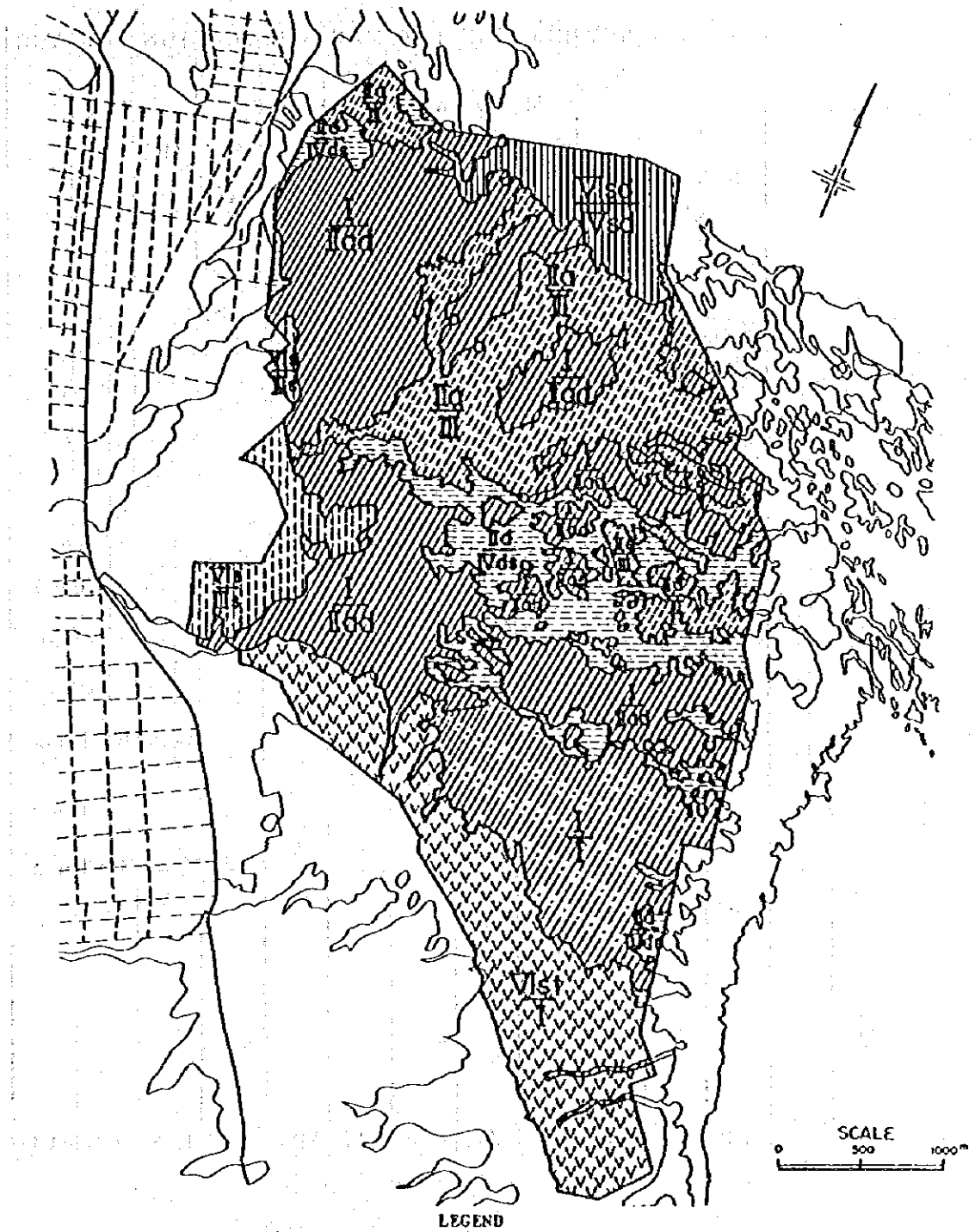
The figure in ( ) is a value required in Japanese standards.
The figure in [ ] is aWHO's reference value not regulated.

Table 5.5.2 Result of Hydraulic Calculation

Point	Quantity of Flow (m^3/s)	Length of Sec. (m)	Pipe Dia (mm)	Velocity (m/s)	Hydroulic Gradeint I	Friction Loss Section (m)	Friction Loss Total (m)	① Head (m)	② Ground Level (m)	① - ② Presser (m)
0								576.00	576.0	0
	0.02063	3,330	200	0.66	0.00338	11.277	11.28			
1								564.72	521.7	43.0
	0.01758	420	200	0.56	0.00251	1.057	12.34			
2								563.66	522.7	41.0
	0.01694	200	200	0.54	0.00235	0.470	12.81			
3								563.19	525.0	38.2
	0.01630	180	200	0.52	0.00218	0.394	13.20			
4								562.80	527.5	35.3
	0.01566	300	200	0.50	0.00203	0.609	13.81			
5								562.19	531.4	30.8
	0.01502	250	200	0.48	0.00188	0.470	14.28			
6								561.72	529.5	32.2
	0.01246	150	150	0.71	0.00540	0.810	15.09			
7								560.91	533.5	27.4
	0.01117	280	150	0.63	0.00441	1.235	16.33			
8								559.67	539.5	20.2
	0.01036	400	150	0.59	0.00383	1.535	17.86			
9								558.14	548.4	9.7
	0.00955	350	150	0.54	0.00330	1.155	19.02			
10								556.98	549.0	8.0
	0.00873	150	100	1.11	0.02014	3.021	22.04			
11								553.96	544.8	9.2
	0.00792	230	100	1.01	0.01681	3.868	25.91			
12								550.09	539.7	10.4
	0.00637	300	100	0.81	0.01123	3.370	29.28			
13								546.72	531.0	15.7
	0.00488	300	100	0.62	0.00685	2.057	31.34			
14								544.66	526.3	18.4

Calculation of the amount of Flowing to Musufini Village (Present Pipes)

							11.28			
1								564.72	521.7	43.0
	0.00305	122	65	0.92	0.02340	2.855	14.14			
15								561.86	522.4	39.5
	0.00203	512	50	1.03	0.03952	20.235	34.37			
16								541.63	521.0	20.6
	0.00102	200	50	0.52	0.01104	2.209	36.58			
17								539.42	521.0	18.4
	0.00102	151	40	0.81	0.03275	4.945	41.53			
18								534.47	520.0	14.5



LEGEND

Soil Families (Soil No.)	Land Classification For Paddy	For Upland crop	Acreage (ha)	Soil Families (Soil No.)	Land Classification For Paddy	For Upland crop	Acreage (ha)
1	VIs	IIIs	55	8	VIst	IVsd	60
3	IIId	VIad	5	9	I	IId	475
4	IId	IVds	160	10	IIa	IIIad	210
6	VIst	I	205	11	I	I	170

ex.) VIst - For Paddy
I - For Upland crop

Total 1,340

Fig. 3.2.1 Land Classification Map

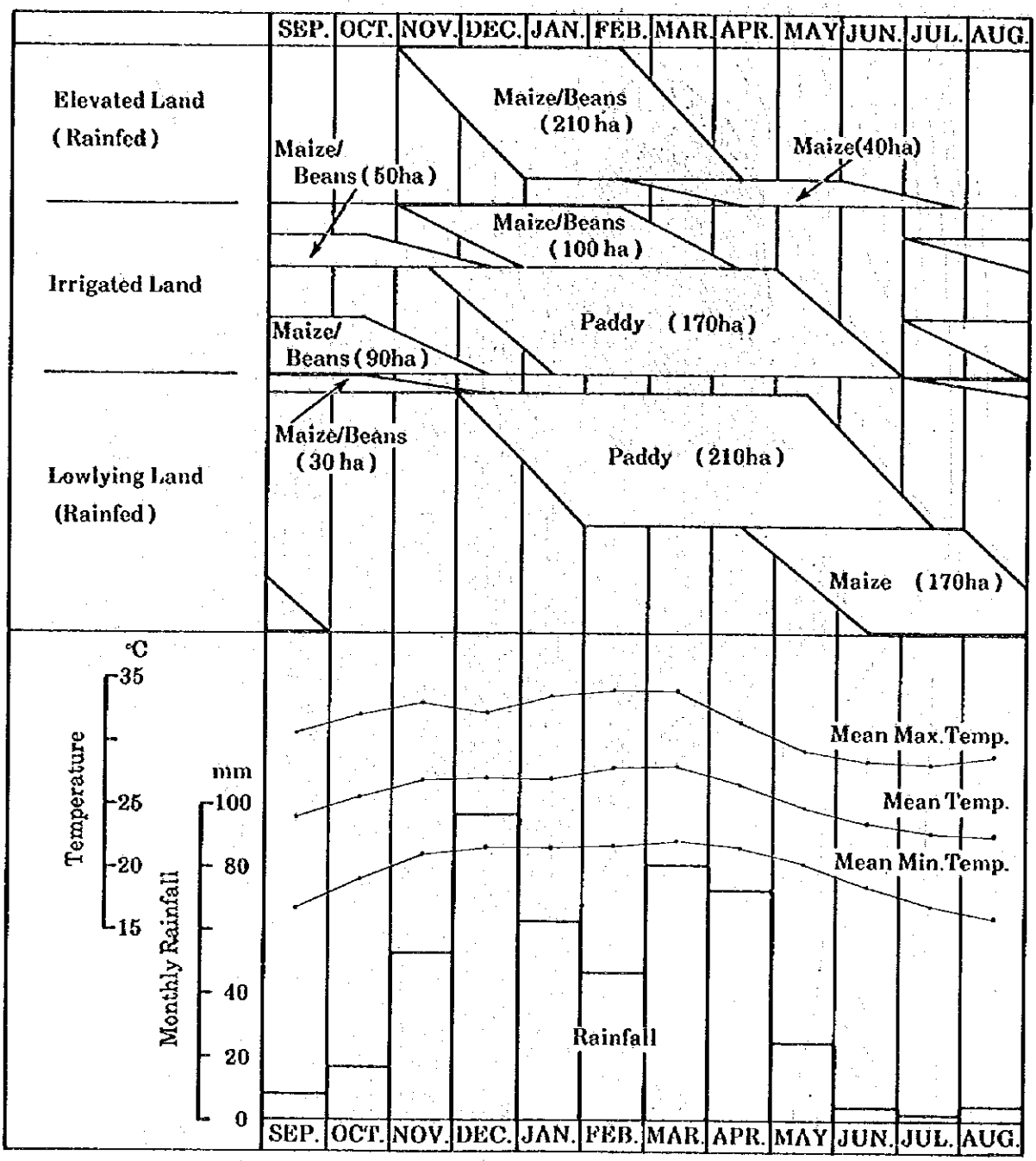


Fig. 3.4.1 Present Cropping Pattern

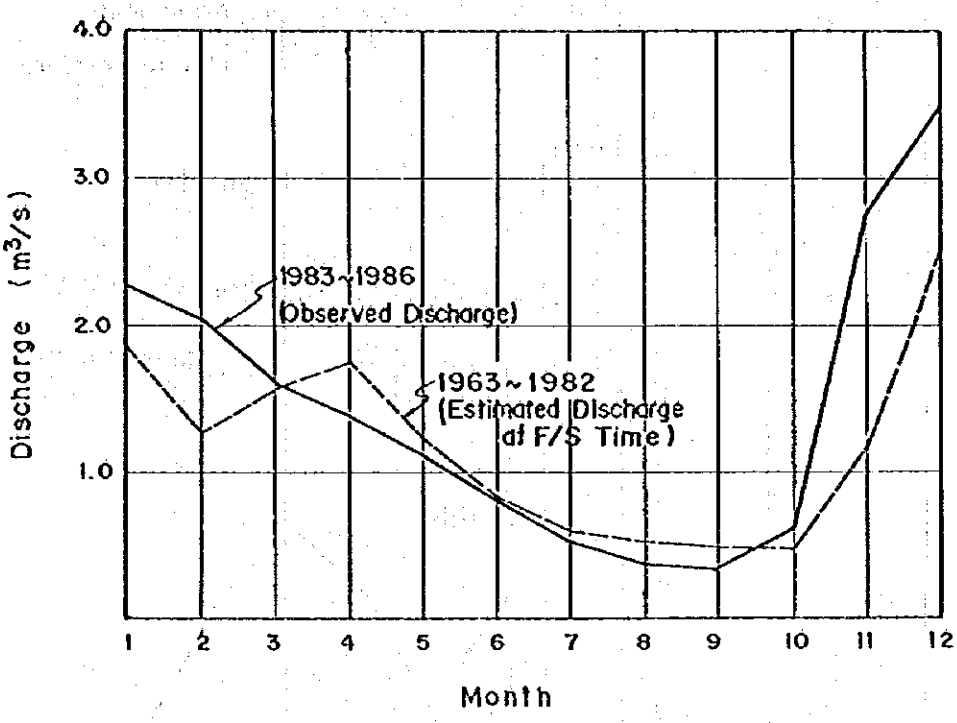


Fig. 5.1.1 Monthly Flow Discharge of Yongoma River

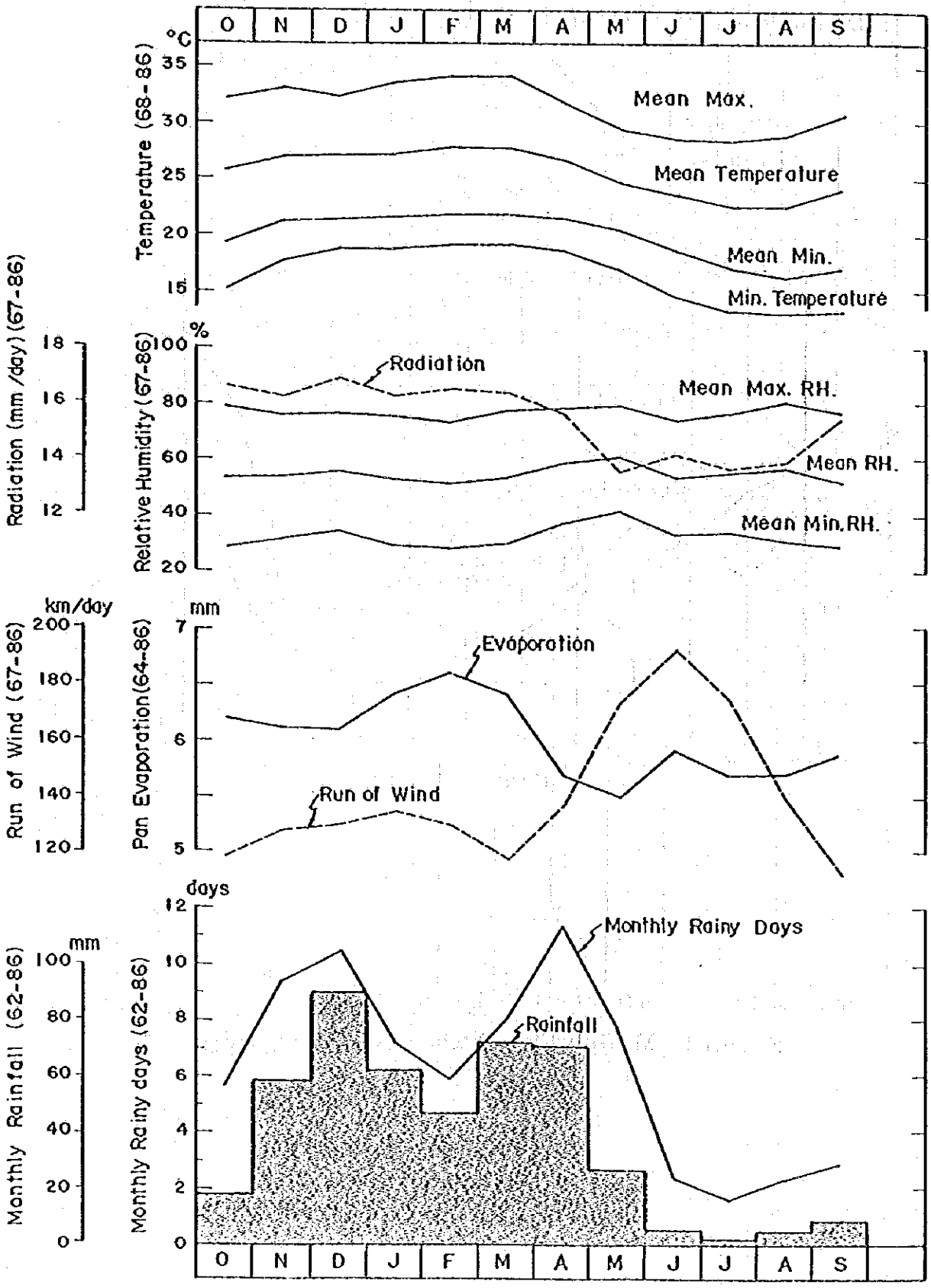


Fig. 5.1.2 Climatic Features at Kalimawe Meteorological Station

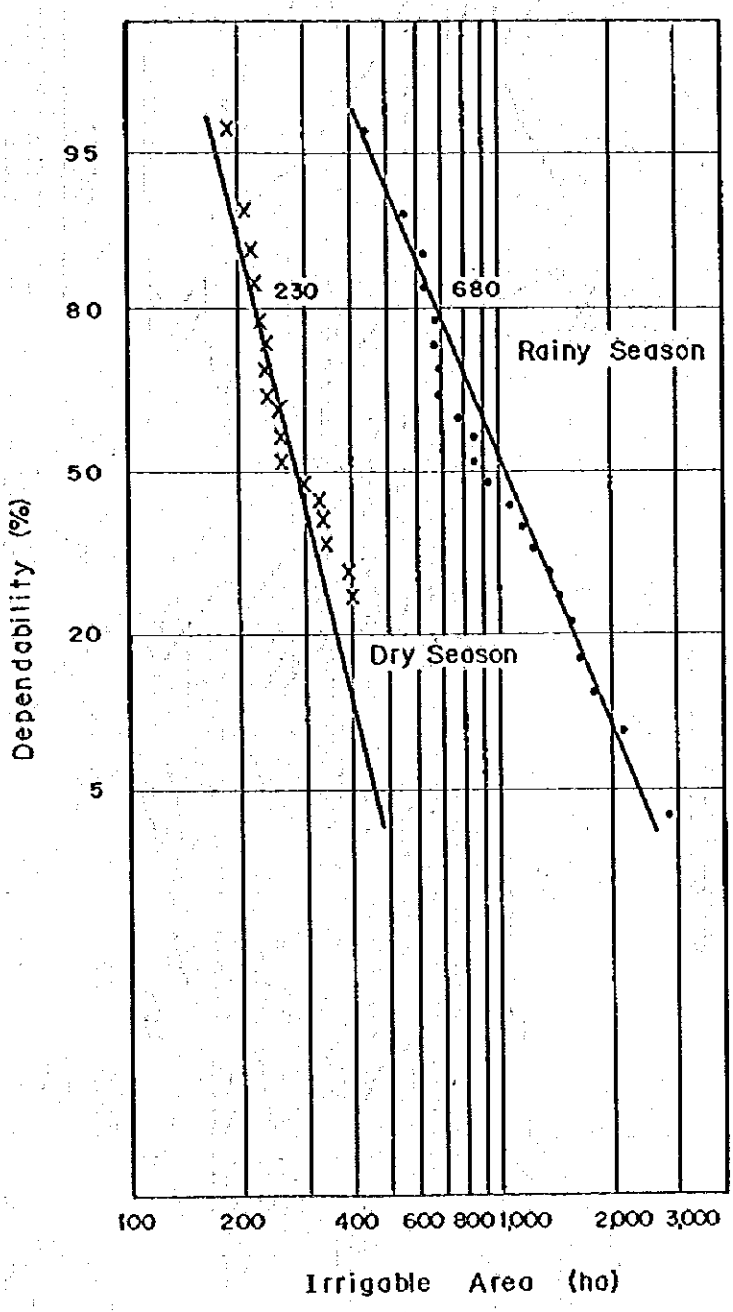
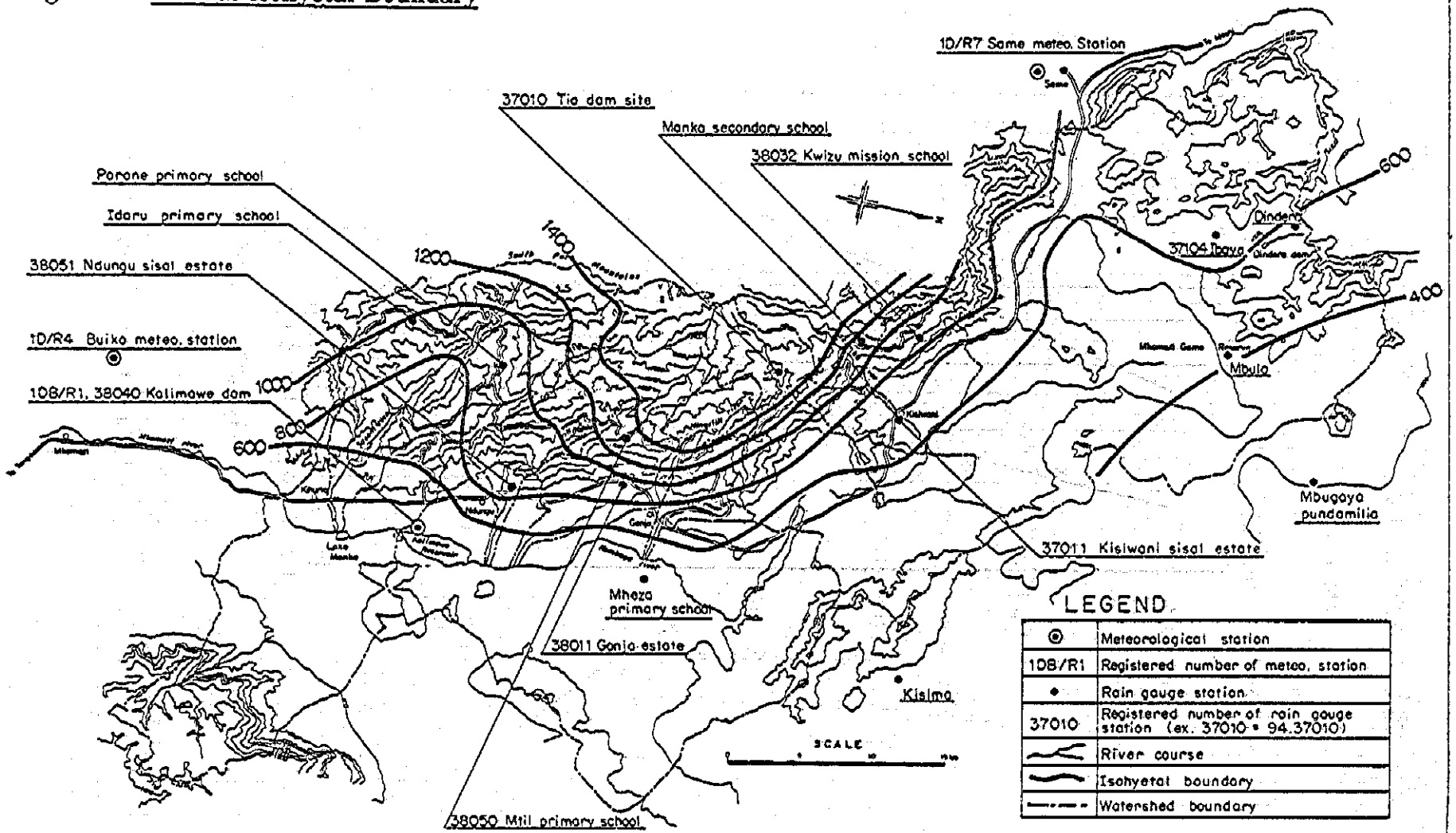


Fig. 5.1.3 Irrigable Area

Fig. 5.1.4 Annual Isohyetal Boundary



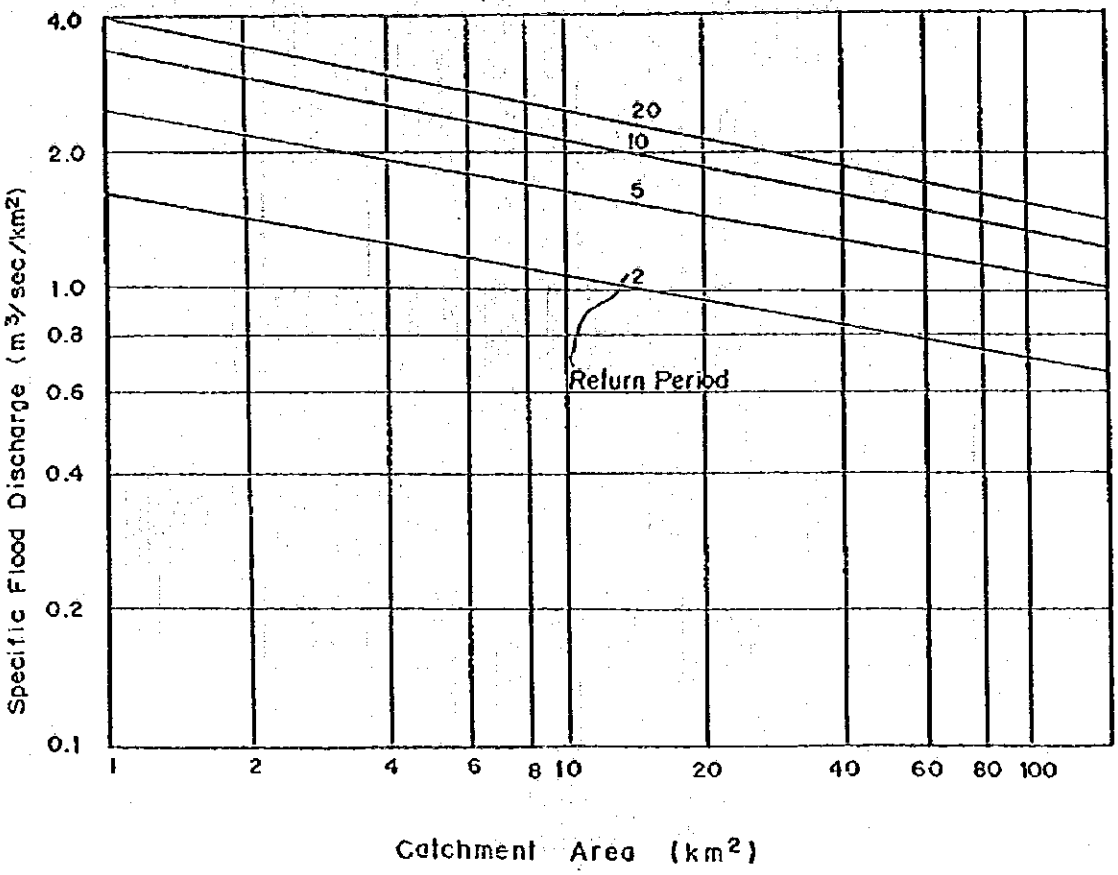


Fig. 5.1.5 Relation Between Specific Flood Discharge and Drainage Area

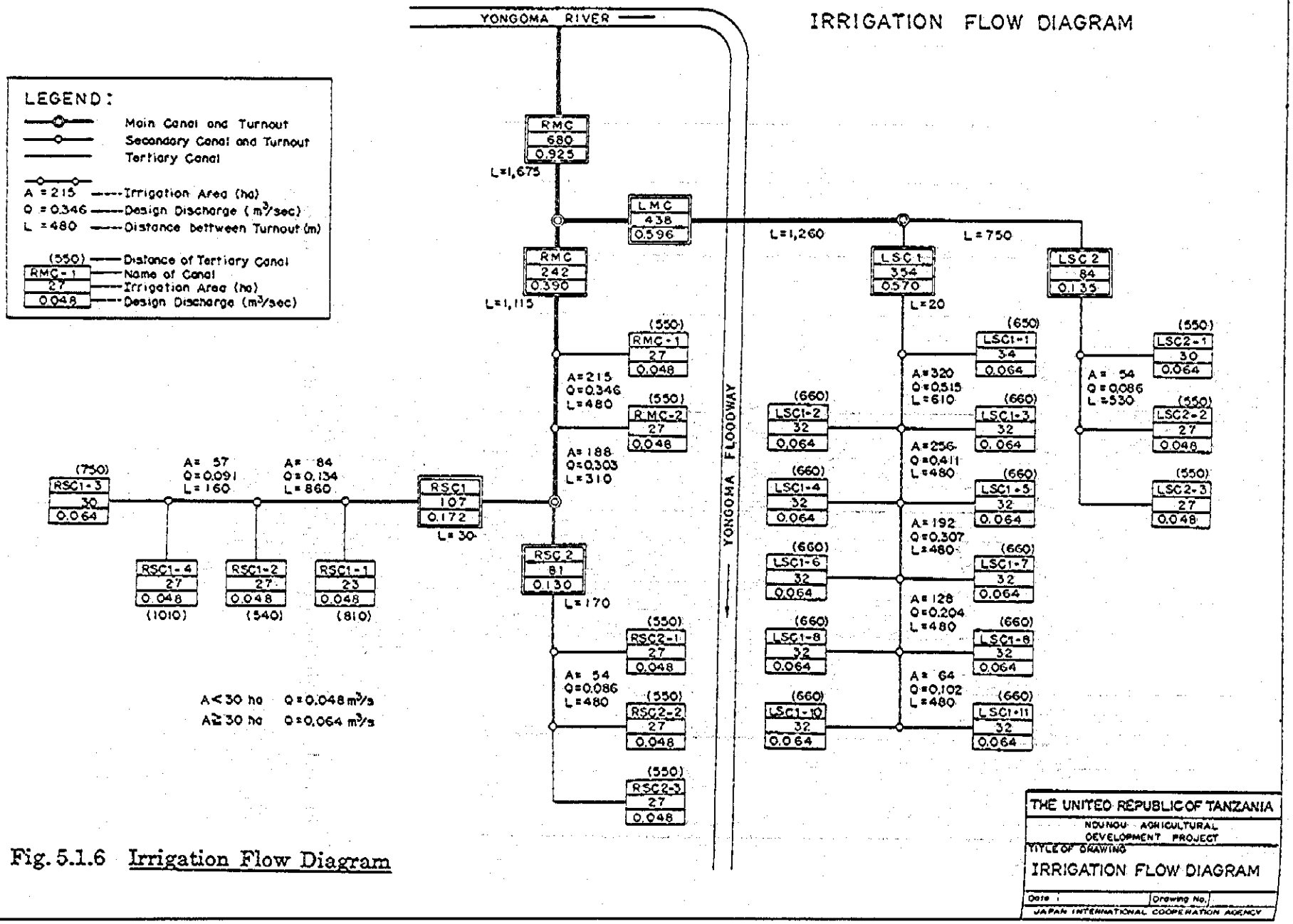


Fig. 5.1.6 Irrigation Flow Diagram

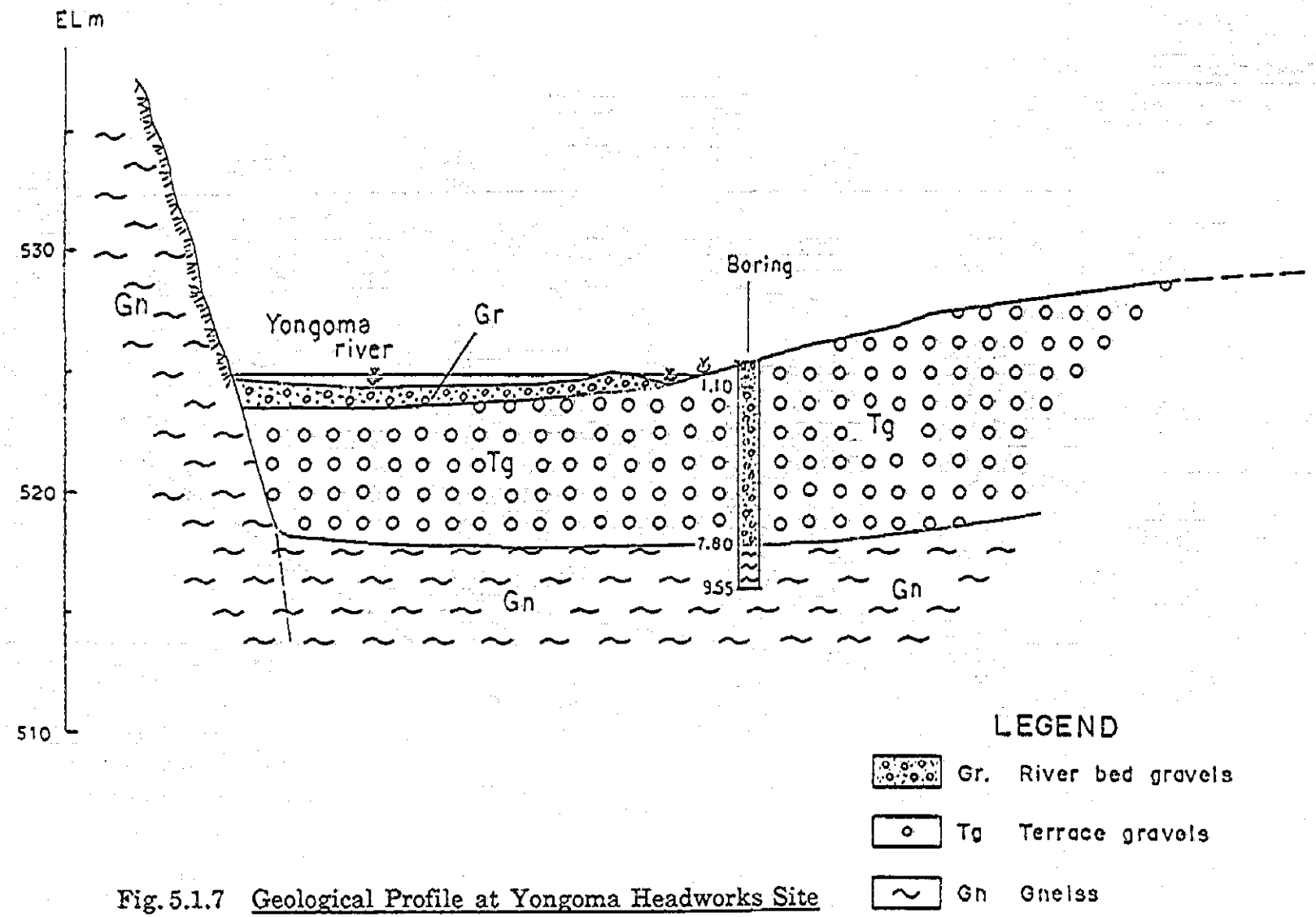


Fig. 5.1.7 Geological Profile at Yongoma Headworks Site

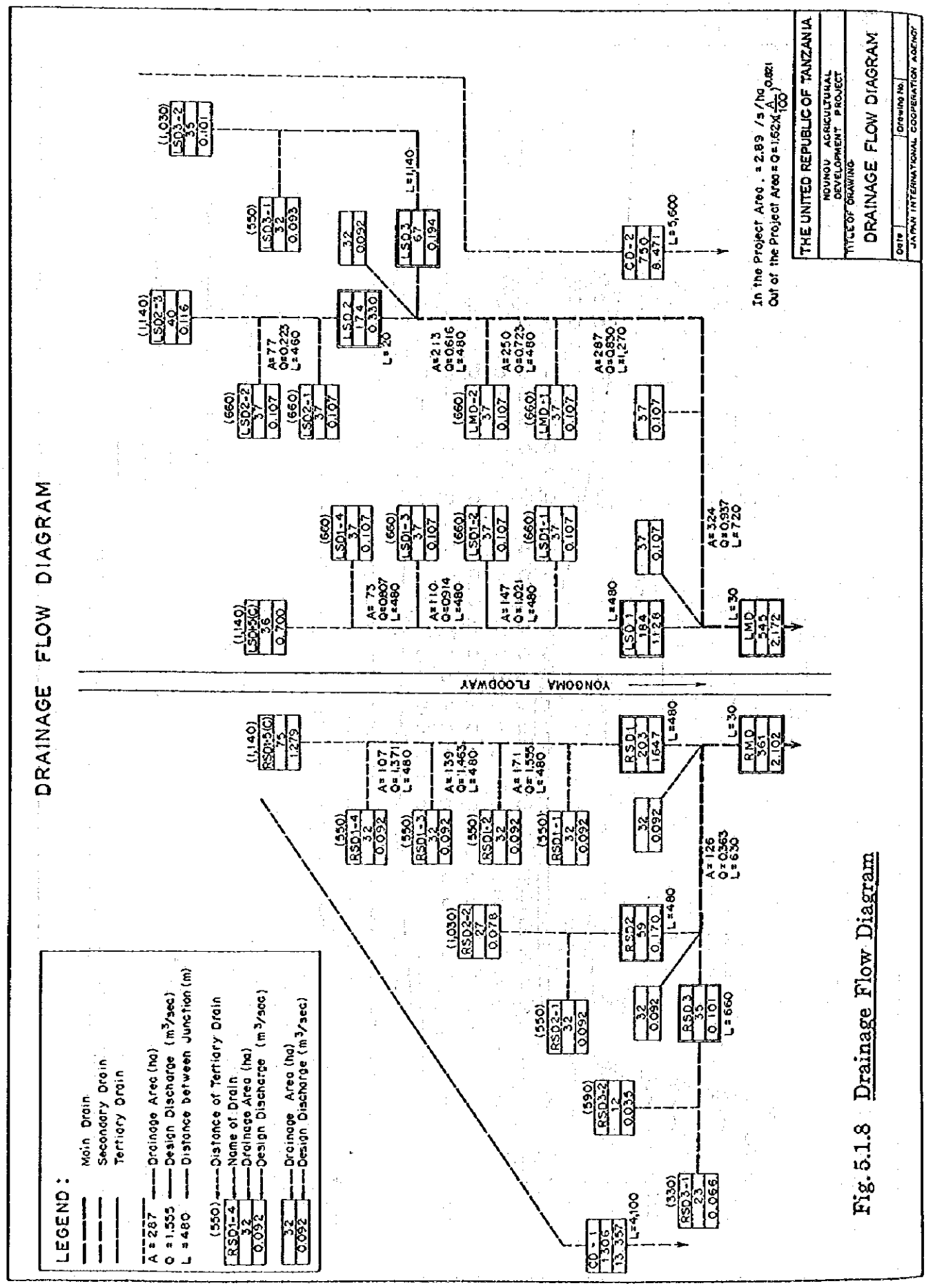


Fig. 5.1.8 Drainage Flow Diagram

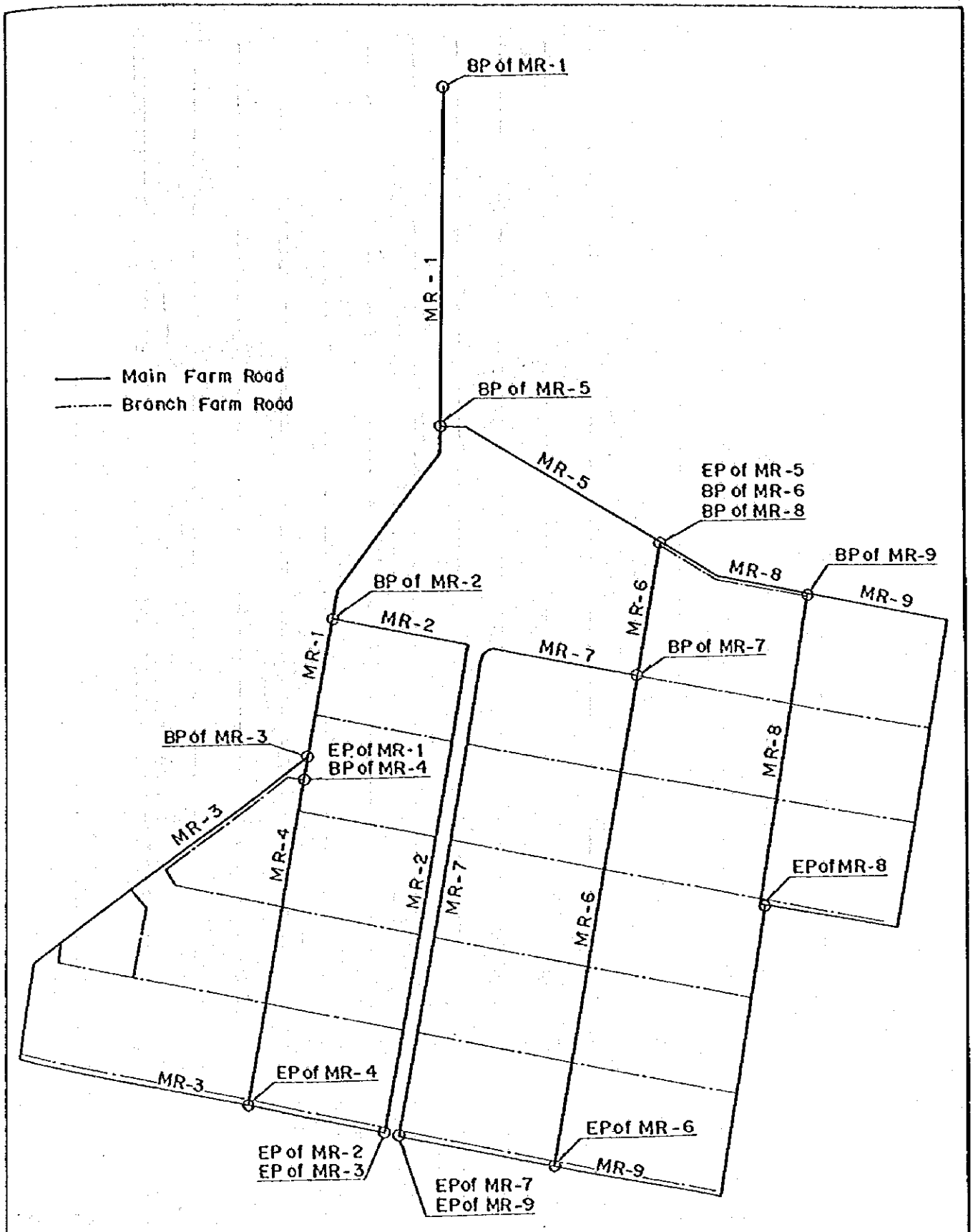


Fig. 5.1.9 Layout of Farm Road

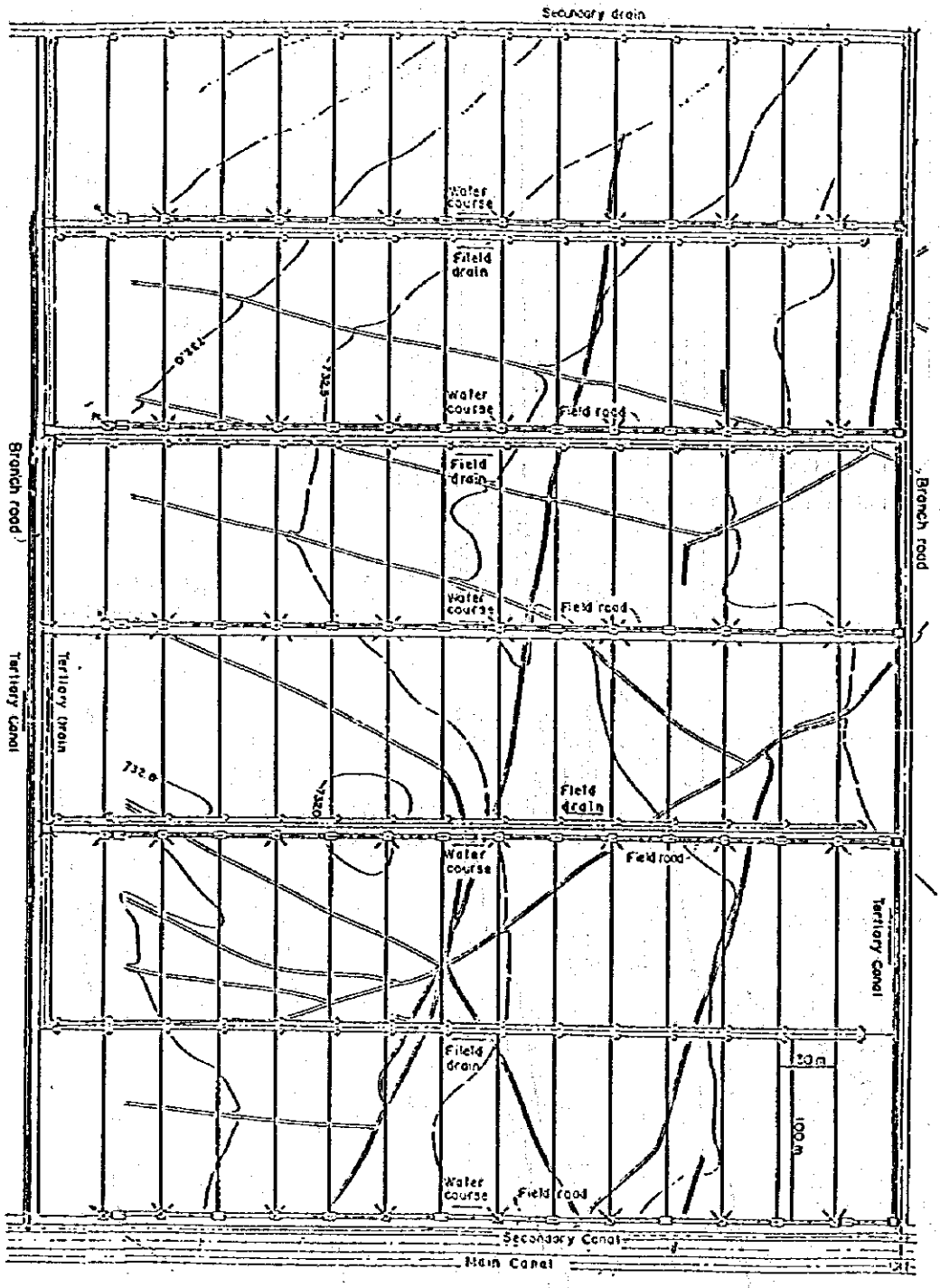


Fig. 5.1.10 Typical Farm Layout

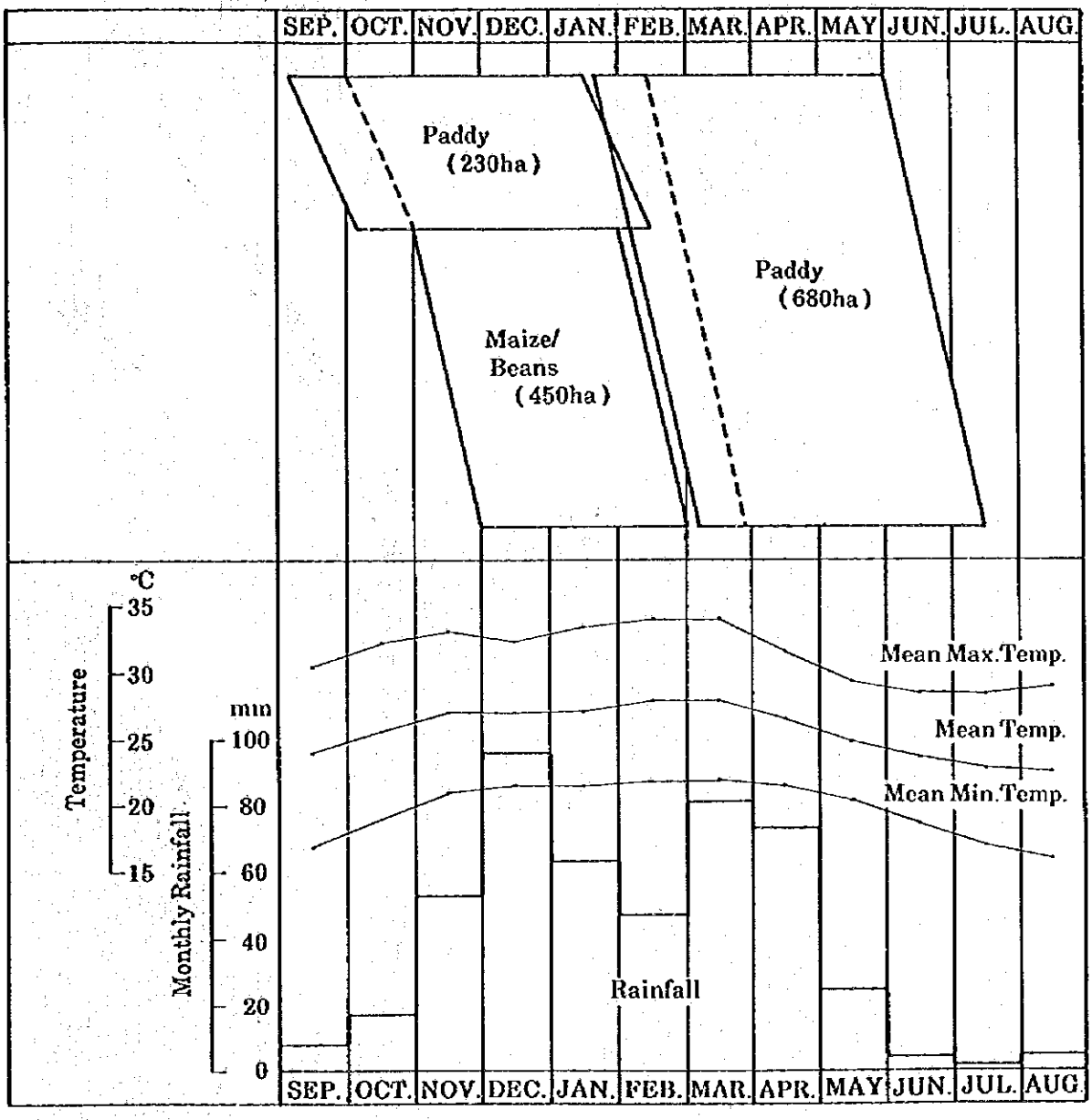


Fig. 5.2.1 Proposed Cropping Pattern

Fig. 5.5.1 Proposed Service Area of Water Supply

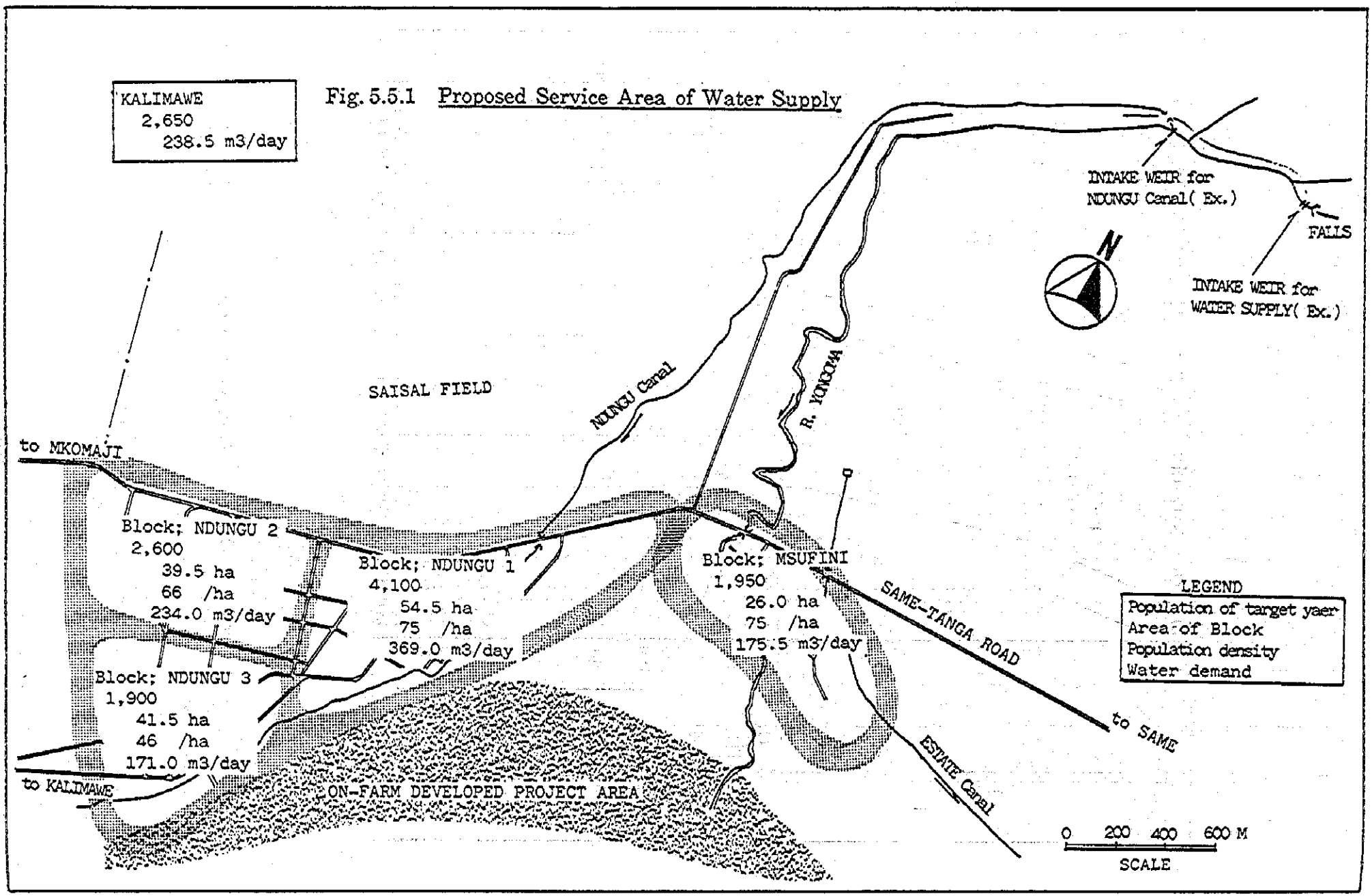


Fig. 5.5.2 Proposed Pipe Arrangement