$$C = 1.354 + 0.004 / 0.129 \cdot (0.14 + 0.2 \sqrt{(0.15)} \cdot (0.155/0.7 - 0.09)^2$$

$$= 1.354 + 0.026 \times 0.656 \times 0.009 = 1.354$$

$$Q = 1.354 \times 0.155^{5/2} = 0.0128 \ m^3/s$$

(3) Specific runoff

According to the topographic map (scale : 1/50,000), the catchment area of the two sites are 23.76 sq.km in the Nyakomba and 35.87 sq.km in the Tsambanena. Each specific runoff is noted below.

Nyakomba Sr = 8.2 ℓ / 23.76 sq.km = 0.34 ℓ / sq.km

Tsambanena Sr = 12.8 ℓ / 35.87 sq.km = 0.36 ℓ / sq.km

(4) Collected Data

The collected data are compiled in Tables A.3.3.1 to A.3.3.11 in the Annex Report.

3.3.3 Soil and Land Capability Classifications

1. Objectives

It is necessary to survey the soil and land in the study area for the proper planning of irrigation and agriculture. The soil and land surveys have already been carried out by AGRITEX. Therefore, this survey is for the purpose of conforming and reinforcing the study area.

2. Soil Survey Method

The soil survey is put into practice through the following procedures.

i. review and application of existing data,
ii. field checking by reconnaissance survey,
iii. detailed field survey,
vi. preparation of land capability map,

Of which, the detailed field survey methods are explained below.

1) Soil Survey by Excavation Pits

(a) Test pits (Type-I) 1m in depth from the soil's surface at 12 sites.

These twelve sites consist of 9 sites in the study area and 3 sites in

the Nyamaropa Irrigation Scheme, i.e. out of the study area.

(b) Test pits (Type-II) 30cm in depth from the soil's susrface, 18 sites. All of the 18 sites are in the study area. Therefore all of the test pits (Type-I) and (Type-II) come from 30 sites, but 27 are in the study area.

All the sites in which the soil survey by excavation pits were carried out. The symbol-P (P1, P2 ～) which was carried out by AGRITEX and symbol-Q (Q1, Q2 ～) was carried out by JICA, plotted on the Soil Map. The symbols Q1 to Q9 and Q101 to Q118 belong to each of the test pits (Type-1) and (Type-II).

2) Soil Survey by Boring

It was impossible to carry out the boring with a hand auger, because the soil became very hard owing to the dry season. Therefore, the team changed to a manpower system, that is to dig shallow pits at between 30 to 40cm deep.

3. Field Survey

1) Procedure

The field survey started on the 29th of August and ended on the 12th of September. The soil profiles were obserbed with 3 sample collections per pit from different layers for laboratory analysis at the university of Zimbabwe.

Two samples were taken from 2 layers in each pit for the measuring of physical characteristics. These samples are undisturbed ones. The total number of samples was 36 to be analyzed in the laboratory.

2) Soil Profile Survey Results

The results from the soil profile survey in the study area are shown in Tables 3.3.3 and 3.3.1.

(1) Soil Layer Plowed Depth

The ploughed depth is 15 cm on average. This value was obtained from 27 pits.

(2) Soil Colour

The soil's colours are reddish brown, dull reddish brown or red. Generally speaking, it can be called red soil.

(3) Soil Texture

The soil's texture is surface Sandy loam except for two pits (Sandy clay loam) and most of the subsoil is more rich clay. Therefore water retentivity is easily available without checking and limiting factors do exist for crop production and farm practices.

(4) Soil Hardness

The hardness of the soil largely varies in study area owing to clay soils, undeveloped soil structures and a low water content in the dry season. The value of Q3 is small due to clay loam. No significant differences between A and B except for the water content. Usually, ploughing and sowing are very difficult without rainfall because of very hard soil and a low soil moisture.

(5) Horizon boundary, Mottling, Humus.

Those characteristics do not exist in all the surveyed pits where the soil profiles are very homogeneous and monotonous in vertical and horizontal directions.

(6) Soil Depth

The soil depth holds 1 m or more from the soil's surface. Only Q3 has a mixed layer with a lot of small gravel below 70cm in depth from the soil surface. No difficulties have been noticed in the Project area for crop production, farm practice and others.

(7) Gravel Content

From the results of the survey, it is possible to say that gravel is nil therefore, there are no problems for crop production and farming practices.

(8) Land Slop

Although the land is only gently inclined traces of erosion are seen in someplaces. Therefore, it is necessary to take measures to correct the situation such as contour ridges, etc.

3) Laboratory Analysis

(1) Sample Number

The physical and chemical characteristics of the soil are analized at the University of Zimbabwe. The following characteristics shall be analyzed.

The symbols Ao, A and B show soils sampled at 5-10cm in depth, 12-20cm in depth and 50-60cm in depth from the soil's surface, respectivcly. Since three samples in each pit were taken from twelve places, the total amount of samples is 36.

(2) Physical and Chemical Analysis

The following 11 charactristics are analysed in the laboratory.

a) particle size distribution, b) true specific gravity,
c) pH value (H_2O), d) electric conductivity, e) C, f) N,
g) P_2O_5, h) K_2O, i)CEC, j) exchangeable bases (Ca, Mg, K, Na,),
k) bulk density.

(3) Analysis Results

There are no special problems found in the results as shown in Table 3. 3.3 ~ 3.3.5 and Fig. 3.3.3.

4) Intake Rates and Water Holding Capacity in the Field

The soils in the irrigation area are classified mainly into two types, Sandy clay loam and sandy loam.

The measurements of field intake tests at 3 points in the irrigation areas were carried out under dry season and no crops conditions in the middle of September 1989. The locations are refered to on the general map attached. The results of the mesurements are shown in Table 3.3.6 and Fig.3. 3.4 respectively, and the infilteration velocity (I) and cumulative infilteration (d) are expressed as follows.

No.1 (Sandy loam)	$I=110T^{-0.389}$mm/hr	$D=3T^{0.611}$mm
No.2 (Sandy clay loam)	$I=171T^{-0.813}$	$D=3.49T^{0.817}$
No.3 (Sandy loam)	$I=264T^{-0.268}$	$D=6T^{0.732}$

where T=infilteration time (min)

Table 3.3.3 Results of Soil Profile Survey

Pit Symbol	Survey Date	Village	Depth of Plowed Soil	Soil Color	Soil Texture	Soil Hardness A	Soil Hardness B
Q-3	3, Aug.	Nyachare	15	Red 4/6 (7.5R)	Sandy-loam	23	20
Q-1	29, Aug.	〃	15	Reddish-brown 4/6(5YR)	Sandy-loam	30	35
Q-2	30, Aug	〃	15	Reddish-brown 4/6(5YR)	Sandy-loam	28	28
Q-5	31, Aug.	〃	15	Dull reddish brown 4/3(5TR)	Sandy-clay loam	30	32
Q-4	31, Aug.	Choo	15	Red 4/8 (7.5R)	Sandy-loam	27	31
Q-9	1, Sep.	Mwarazi	15	Reddish-brown 4/3(10R)	Sandy-loam	30	30
Q-6	1, Sep.	〃	15	Dull reddish brown 4/4(5YR)	Sandy-loam	32	27
Q-7	1, Sep.	Nyamanhika	15	Reddish-brown 4/6(5YR)	Sandy-loam	32	227
Q-8	1, Sep.	〃	15	Reddish-brown 4/4(10R)	Sandy-clay loam	30	30
Q-10	5. Sep.	Nyamaropa Irri. Scheme	20	Dull reddish brown 4/4(2.5YR)	Sandy-loam	31	20
Q-11	5, Sep.	Nyamaropa Dry Land	15	Dull reddish brown 4-4(5YR)	Sandy-loam	30	30
Q-12	5, Sep.	〃	15	Dull reddish brown	Sandy-loam	28	28

Note: (1) The results obtained from the pit of 1m deep from are shown on Table.
(2) The symbol A and B show at points about 15 and 50 cm deep, respectively.
(3) Pit symbols Q-10, Q-11, Q-12 are in irrigated area, out of Study Area.

Table 3.3.4 Results of Soil Profile Survey

Pit Symbol	Survey Date	Village	Depth of Plowed Soil	Soil Color	Soil Texture	Soil Hardness A	Soil Hardness B
Q-101	2, Sep.	Nyachere	15	Reddish -brown	Sandy-loam	32	-
Q-102	〃	〃	15	〃	〃	31	-
Q-103	〃	〃	15	Dull red-dish brown	〃	29	-
Q-104	〃	〃	15	Reddish -brown	〃	30	-
Q-105	〃	〃	15	〃	〃	30	-
Q-106	〃	〃	15	Dull red-dish brown	〃	30	-
Q-107	〃	〃	15	Reddish -brown	〃	30	-
Q-108	〃	〃	15	〃	〃	30	-
Q-109	4, Sep.	Nyakomba -2a	15	Dull red-dish brown	Sandy-clay loam	28	-
Q-110	〃	〃	15	〃	〃	29	-
Q-111	〃	Nyamanhika	15	〃	〃	25	-
Q-112	〃	〃	15	〃	〃	25	-
Q-113	〃	Mwarazi	15	〃	〃	28	-
Q-114	〃	〃	15	〃	Sandy-loam	25	-
Q-115	〃	〃	15	〃	〃	26	-
Q-116	〃	〃	15	〃	〃	29	-
Q-117	5, Sep.	Nyachere	12	〃	Sandy-clay loam	28	-
Q-118	〃	Choo	15	〃	〃	29	-

Note: The results were obtained from pits of 30 cm deep.

Table 3.3.5 Result of Soil Analysis (1)

Sample No.	Particle Size Distribution (%) Clay	Silt	Fine Grain Sand	Medum Grain Sand	Coarse Grain Sand	DM	Soil Texture	Bulk Density	pH (H_2O)	Electric Conductivity mS/cm(10^{-2})	Organic Carbon (C) %	Nitrogen (N) ppm (Initial)	Nitrogen (N) ppm (Incubated)
1-Ao	15	8	60	11	6	99.4	SL	1.33	6.1	26.0	2.4	<1	6
A	16	12	55	11	6	99.6	SL	1.71	6.4	29.2	2.5	2	2
B	34	12	39	9	6	96.2	SCL	1.71	6.3	14.5	1.8	<1	3
2-Ao	15	11	60	10	4	99.4	SL	1.51	6.9	62.9	2.3	5	13
A	23	16	51	7	3	98.7	SCL	1.71	7.2	32.1	2.5	1	8
B	30	15	47	6	2	99.6	SCL	1.47	6.9	20.8	1.4	<1	4
3-Ao	15	23	60	1	1	99.0	SL	1.29	6.5	32.4	3.4	8	13
A	12	28	58	1	1	98.4	SL	1.48	6.6	23.6	1.8	1	7
B	17	25	56	1	1	99.6	SL	1.23	6.6	15.4	1.9	<1	7
4-Ao	23	13	47	8	9	99.7	SCL	1.61	6.5	32.7	3.0	<1	4
A	8	11	52	24	5	99.0	SL	1.68	6.1	22.9	1.9	<1	6
B	38	10	34	12	6	99.5	SC	1.54	5.7	16.8	1.4	5	3
5-Ao	16	5	50	22	7	99.9	SL	1.66	6.2	25.0	2.1	<1	3
A	22	16	46	7	7	99.0	SCL	1.52	6.3	28.3	2.5	3	8
B	29	16	37	13	5	99.4	SCL	1.62	6.3	19.0	2.2	<1	3
6-Ao	8	6	62	15	8	99.5	SL	1.31	6.4	28.9	1.2	1	4
A	16	8	60	9	5	99.4	SL	1.68	7.0	22.4	2.3	<1	4
B	29	11	46	9	5	99.3	SCL	1.64	7.2	27.9	1.6	1	1
7-Ao	11	7	58	16	8	99.7	SL	1.43	6.8	39.8	2.1	3	6
A	34	11	40	10	5	99.7	SCL	1.47	6.6	35.3	1.8	1	1
B	45	11	31	8	5	98.2	C	1.36	6.2	24.8	1.6	<1	7
8-Ao	21	11	58	8	2	99.6	SCL	1.45	6.0	19.2	2.5	1	6
A	27	15	48	6	4	97.2	SCL	1.89	6.1	16.2	2.7	<1	6
B	39	14	41	4	2	98.9	SC	1.43	6.0	31.1	1.8	3	5
9-Ao	10	9	64	10	7	99.8	SL	1.33	6.2	34.1	2.0	4	4
A	24	19	45	7	5	99.7	SCL	1.53	6.7	20.3	2.3	<1	9
B	37	18	31	7	6	98.9	CL	1.40	5.8	36.6	2.5	1	7
10-Ao1 /	20	11	44	14	11	99.7	SCL	1.38	6.9	57.1	1.8	1	8
A —	35	15	31	10	9	99.5	SCL	1.40	6.5	40.8	2.1	<1	6
B	43	13	27	7	10	98.2	C	1.48	6.0	43.3	1.7	2	3
11-Ao2/	13	15	59	8	5	99.7	SL	1.46	7.5	100	2.6	1	8
A —	14	20	55	7	4	99.4	SL	1.74	7.2	77.1	3.0	1	11
B	41	16	30	6	4	97.5	C	1.38	6.2	21.5	2.0	<1	5
12-Ao3 /	15	13	40	19	13	99.3	SL	1.40	6.0	30.1	2.1	3	4
A —	16	16	39	18	9	99.5	SL	1.62	5.9	22.1	2.4	<1	3
B	40	14	23	12	11	99.0	SC	1.48	6.3	14.4	1.0	3	4

1/ 2/ 3/ These data are from Nyamaropa irrigation area. Soil texture followed according to the criterion of soil classification in ZIMBABWE.

Table 3.3.5 Result of Soil Analysis (2)

Sample No.	Phoshoric Acid P_2O_5	K_2O	CEC	Exchangeale Base me %					Base sat.	EKP	ESP	Fe_2O_3	Note
		mg%	me%	Ca	Mg	K	Na	TEB	%	%	%	%	
	ppm												
1-Ao	7	5.6	4.56	2.60	0.63	0.12	0.05	3.40	75	3	1	0.60	Symbols of soil texture
A	7	8.3	4.40	2.60	0,68	0.18	0.09	3.55	81	4	2	2.83	
B	22	4.3	7.28	3.95	1.08	0.09	0.12	5.24	72	1	2	2.66	SL : Sandy Loam
2-Ao	9	17.5	5.20	3.30	0.85	0.37	0.12	4.64	89	7	2	0.59	SCL ; Sandy Clay Loam
A	5	17.3	7.02	4.95	1.10	0.37	0.08	6.50	93	5	1	1.96	CL ; Clay Loam
B	<1	8.6	6.18	3.05	0.93	0.18	0.06	4.22	68	3	1	3.17	SC ; Sandy Clay
3-Ao	10	5.2	7.64	5.25	1.70	0.11	0.12	7.18	94	1	2	0.75	C ; Clay
A	3	4.5	7.96	5.00	1.53	0.10	0.07	6.70	84	1	1	1.57	
B	<1	1.9	6.24	4.20	1.60	0.04	0.06	5.90	95	1	1	2.75	
4-Ao	<1	11.5	7.44	4.70	0.95	0.24	0.12	6.01	81	3	1	0.96	
A	3	10.6	2.40	1.80	0.40	0.23	0.05	2.48	103	10	2	1.03	
B	<1	2.6	4.08	1.04	0.40	0.06	0.08	1.58	39	1	2	2.40	
5-Ao	-do-	3.4	2.53	1.25	0.35	0.07	0.09	1.76	70	3	4	0.60	
A	-do-	9.2	3.83	2.40	0.63	0.20	0.10	3.33	87	5	3	1.96	
B	1	5.3	7.20	5.00	1.05	0.11	0.15	6.31	88	2	2	2.06	
6-Ao	8	2.1	2.24	1.40	0.23	0.04	0.02	1.69	75	2	1	0.49	
A	8	2.6	5.56	3.60	0.52	0.06	-	4.18	75	1	-	1.42	
B	<1	2.5	6.76	4.00	0.73	0.05	-	4.78	71	1	-	2.01	
7-Ao	13	7.5	3.60	2.40	0.52	0.16	0.04	3.12	87	4	1	0.65	
A	<1	18.1	5.04	2.90	0.63	0.39	0.19	4.11	82	8	4	2.26	
B	-do-	4.7	5.20	2.65	0.51	0.15	0.10	3.41	66	3	3	2,37	
8-Ao	-do-	4.8	3.68	2.05	0.40	0.10	0.05	2.60	71	3	1	0.81	
A	-do-	3.4	5.00	2.45	0.63	0.07	0.07	3.22	64	1	1	2.25	
B	-do-	2.6	5.52	2.95	0.25	0.06	0.08	3.34	61	1	1	2.39	
9-Ao	-do-	3.5	2.76	2.20	0.45	0.08	0.04	2.77	100	3	2	0.54	
A	-do-	2.5	8.90	4.35	0.65	0.05	-	5.05	57	1	-	1.85	
B	-do-	2.9	6.80	4.30	0.51	0.06	0.10	4.97	73	1	1	2.43	
10-Ao1 /	56	6.0	4.92	5.45	0.95	0.13	0.12	6.65	135	3	2	0.81	
A —	<1	5.5	6.33	3.75	1.05	0.12	0.13	5.05	80	2	2	2.33	
B	-do-	3.9	7.04	4.95	0.88	0.08	0.10	6.01	85	1	1	2.40	
11-Ao2/	68	7.3	7.68	4.80	1.30	0.16	0.18	6.44	84	2	2	0.77	
A —	<1	5.8	8.12	4.15	1.03	0.12	0.14	5.44	67	2	2	1.75	
B	5	4.8	7.80	4.50	1.05	0.10	0.11	5.76	74	1	1	2.71	
12-Ao3 /	<1	5.2	3.16	2.10	0.51	0.11	0.08	2.80	89	4	3	0.46	
A —	-do-	6.3	3.32	1.75	0.51	0.13	-	2.39	72	4	-	1.31	
B	-do-	6.3	6.20	2.48	0.58	0.13	0.10	3.29	53	2	2	2.13	

Table 3.3.6 Record of Intake Rate Measurment

Place : No.1 Date : Sep.21 1989				Place : No.2 Date : Sep.289				Place : No.3 Date : Sep.23 1989			
Passage Time T(min)	Amount of Infiltration Q (mm)	Intake Rate I(mm/hr)	Remarks	Passage Time T(min)	Amount of Infiltration Q (mm)	Intake Rate I(mm/hr)	Remarks	Passage Time T(min)	Amount of Infiltration Q (mm)	Intake Rate I(mm/hr)	Remarks
0	0	0	Start	0	0	0	Starts	0	0	300	Start
1	8	480		1	6	360		1	5	264	
5	11	132		5	22	264		5	22	210	
10	14	84		10	28	168		10	35	184	
15	16	64		15	36	144		15	46	165	
20	18	54		20	45	135		20	55	151	
25	22	53		25	52	125		25	63	146	
30	24	48		30	59	118		30	73	134	
40	29	44		40	76	114		40	89	124	
50	33	40		50	89	107		50	103	115	
60	37	37		60	99	99		60	115	108	
70	41	35		70	113	97		70	126	104	
80	44	33		80	126	95		80	139	100	
90	46	31		90	139	93		90	150	98	
100	49	29		100	151	91		100	163	93	
200	81	24		140	196	84		115	179	89	
300	103	21		200	257	77		130	192	85	
400	111	17		260	320	74		160	226	82	
648	178	17		320	382	72		175	240	79	
.	.	.		330	393	72		220	290	77	
.	.	.		380	440	70		265	340	76	
.	.	.		440	501	68		310	393	73	
1,120	240	13		500	560	67		385	469	70	

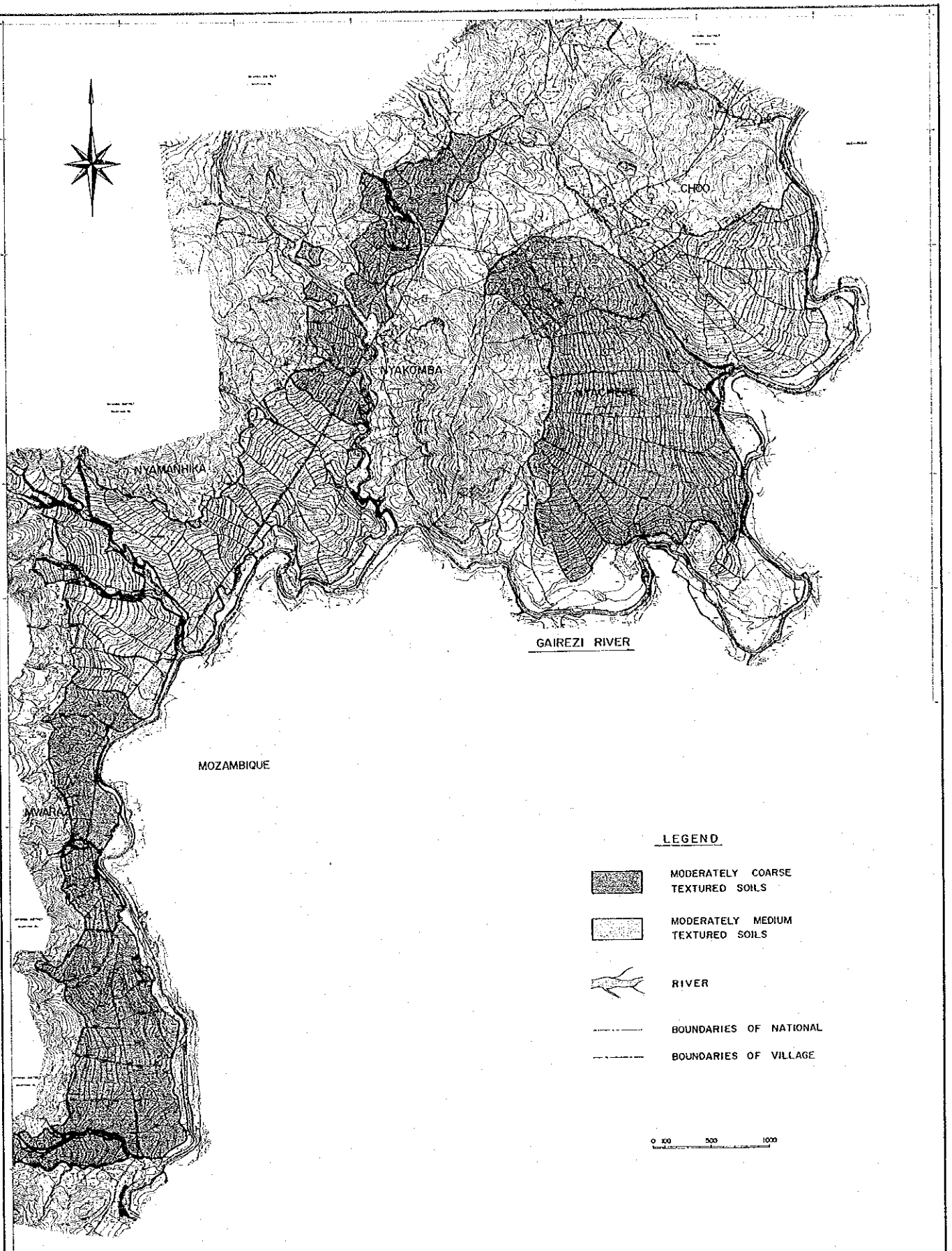


Figure 3.3.3. SOIL TEXTURE MAP
(SURFACE HORIZON)

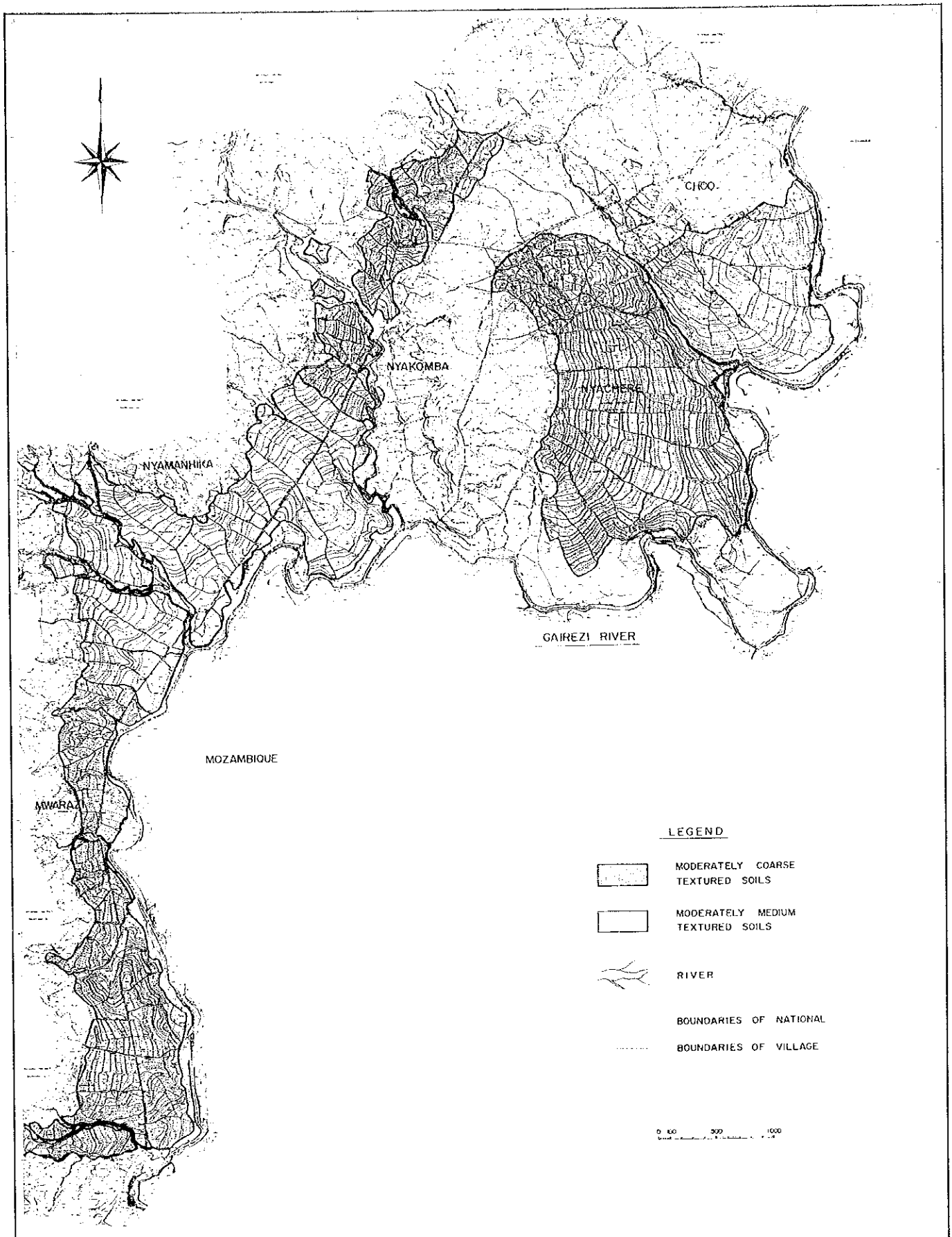


Figure 3.3.3. SOIL TEXTURE MAP
(SURFACE HORIZON)

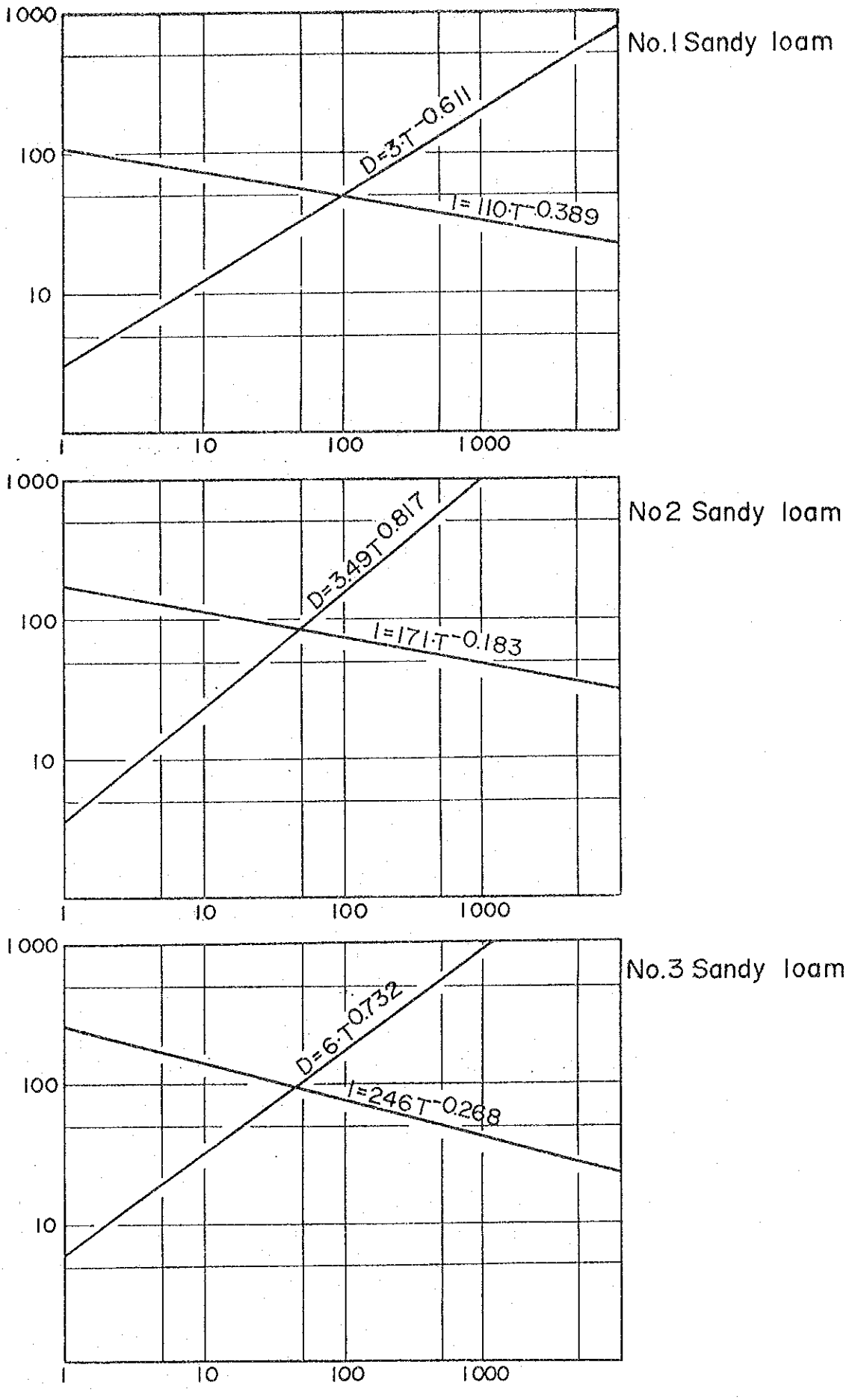


Fig. 3·3·4 Intake Rate

For the measurement of the water holding capacity in the fields, a 24 hour water contents in the soil at the same points as the intake rate tests were measured. The results are shown in Table 3.3.7. The water holding capacity of the soils is constantly at 60 percents of the mean values.

4. Land Capability Classification

Agricultural land can be classified in a number of different ways depending on the objectives of the classification. In Zimbabwe, eight land capability classes are recognised and these may be divided into three land capability divisions. The following Table 3.3.8 illustrates how the land classes and divisions are arranged in order of decreased adaptability and freedom of usage choice.

According to the Ward Development plan for the Nyakomba Ward provided by AGRITEX, the land capability was classified into five categories as shown in Table 3.3.9.

Land Classes I and II in total are 1,737ha and are arable land for cropping. The Class II area is only down-graded due to its slope percentage.

5. Land Capability Classification for Cultivated Land

JICA provided the topographic maps at a scale of 1:5,000 in December 1989. These topographic maps cover the cultivated areas of the Nyakomba Ward excluding the Nyatsawe village area. The source of these maps was aerial photographs at a scale of 1:25,000 in 1986.

Based on these topographic maps, soil survey results and their analysis and natural conditions such as cultivated land, grazing area, rivers/drainage channels and so forth observed in the project area, cultivated lands are classified into four categories such as Class I, II, VIa and VIb.

Class I: Land with few or no limitations or hazards. With good management it is suitable for continuous crop production with no or simple conservation practices.

- Slope: (Maximum permissible slope) : 2%
- Depth: (Minimum effective depth) : 1.0m of clay loam or heabier

Table 3.3.7 Result of Measurement of Water Holding Capacity and Three Phase Distribution of Soil Saturation

Sample No.	Nos.	Vo (cm^3/%)	Wo (g)	Ws (g)	Ds	Vs:Ws/Ds (cm^3/%)	Vw:WO-Ws (cm^3/%)	Va:100-(Vs+Vw) (cm^3/%)	Note
No.1-A	2	100	167.5	130.8	2.66	49.2	36.7	14.1	Symbol;
d=12.5 cm			177.9	141.7	2.63	53.9	36.2	9.9	
	mean				2.65	51.6	36.5	11.9	Vo = Volume of soil sampled
-B									
d=32.5 cm	2		180.9	142.9	2.72	52.5	38.0	9.5	Wo = Weight of soil sampled
			181.9	144.2	2.63	54.8	37.7	7.9	
	mean				2.68	53.7	37.9	8.5	Ws = Weight of ovendry soil sampled
-C									
d=62.5 cm	2		187.7	151.2	2.69	56.2	36.5	7.3	Ds = Real spesific gravity of soil sampled
			180.1	145.1	2.68	54.1	37.0	8.9	
	mean				2.69	55.2	36.8	8.1	Vs = Volume of soil
No.2-A									
d=12.5 cm	2		171.9	136.4	2.66	50.9	35.5	13.6	Vw = Volume/Weight of water in the soil sampled
			172.4	136.7	2.69	50.8	35.7	13.5	
	mean				2.68	50.9	35.6	13.6	
-B									Va = Volume of air space in the soil sampled
d=32.5 cm	2		181.8	145.2	2.66	54.6	36.6	8.8	
			182.6	145.8	2.66	56.8	36.8	8.4	
	mean				2.66	55.7	36.7	8.6	
-C									
d=62.5 cm	2		181.1	145.0	2.66	59.7	36.1	9.0	
			183.3	147.1	2.67	57.7	36.3	8.6	
	mean				2.67	58.7	36.2	8.8	
No.3-A									
d=12.5 cm	2		182.8	147.7	2.70	54.7	35.1	10.2	
			178.4	143.6	2.66	54.0	34.8	11.2	
	mean				2.68	54.3	35.0	10.7	
-B	2		188.2	151.8	2.63	57.7	36.4	5.9	
			185.4	149.0	2.68	55.6	36.4	8.0	
	mean				2.66	59.9	36.4	6.9	
-C	2		194.7	158.7	2.65	56.7	36.0	4.0	
d=62.5 cm			191.7	155.6	2.61	57.8	36.1	6.1	
	mean				2.63	58.8	36.1	5.1	

Table 3.3.8 USE OF LAND ACCORDING TO CAPABILITIES

Land Capability Class		Increased intensity of use									Land Capability Class
		Wildlife	Forestry	Limited Grazing	Moderate Grazing	Intensive Grazing	Limited Cultivation	Moderate Cultivation	Very Intensive Cultivation		
Increased limitations and hazards Decreased adaptability and freedom of choice of uses	I	W	F	LG	MG	IG	LC	MG	IC	VIC	Arable Land
	II	W	F	LG	MG	IG	LC	MC	IC		
	III	W	F	LG	MG	IG	LC	MC			
	IV	W	F	LG	MG	IG	LC				
	V	W	F	LG	MG	IG					Gezing Land
	VI	W	F	LG	MG						
	VII	W	F	LG							
	VIII	W									No agricultural value.

Table 3.3.9 LAND CAPABILITY CLASSIFICATION

Village (VIDCO) No. Name	Land Class (ha) I	II	VI	VII	VIII	Total
1. Nyatsawe	-	367	451	320	31	1,169
2. Nyakomba	-	186	281	237	23	727
3. Choo	-	290	322	169	9	790
4. Nyachere	-	402	425	47	11	885
5. Nyamanhika	-	228	824	286	17	855
6. Mwarazi	38.5	225.5	396	224	13	897
Total (Ward)	38.5	1,698.5	2,199	1,283	104	5,323

Source; Ward Development Plan for Ward No.3 Nyakomba, AGRITEX, July 1989

Table 3.3.10 LAND CAPABILITY OF CULTIVATED LAND

Village No. Name	Land Class (ha) I	II	VIa	VIb	Total
2. Nyakomba	-	161.2	9.0	67.7	237.9
3. Choo	-	182.7	20.4	3.4	206.5
4. Nyachere	-	318.1	36.1	6.1	360.3
5. Nyamanhika	-	307.4	16.7	8.6	332.7
6. Mwarazi	29.0	200.3	28.7	1.5	259.5
Total	29.0	1,169.7	110.9	87.3	1,396.9

Source: JICA, Study Team

Class II: Land subject to moderate limitations or hazards. It is suitable for cropping with adequate protection measures, which may sometimes include special management practices and/or regular lay rotations.

- Slope: 5%
- Depth: 0.50m of sandy loam or heavier

Class VIa; Cultivated land which has such severe soil and/or slope limitations. Limitations include very steep slopes, very shallow soil, physical hazards of rock outcrops, uneveness and so forth, protection measures and practices for surface soil erosion would be required.

Class VIb; Land with a moderate slope and a suitable soil depth for cultivation, but is on the river side which is occasionally inundated by heavy flood. Crop production should be limitted with the viewpoint of soil conservation.

Areas of cultivated land in each category are measured by a planimeter on the topographic maps. Results of that are shown in Table 3.3.10 Land Capability of Cultivated Land and Fig. 3.3.5 Land Capability Map.

The total calculated area is 1396.9ha, out of which 1198.7ha is arable land classified in Class I and II.

It was noted that the figure for cultivated land/arable land which have been prepared by the Ward Development Plan, JICA study Team and AGRITEX Nyanga office respectively (refer Table 3.3.9, Table 3.3.10) have discrepencies.

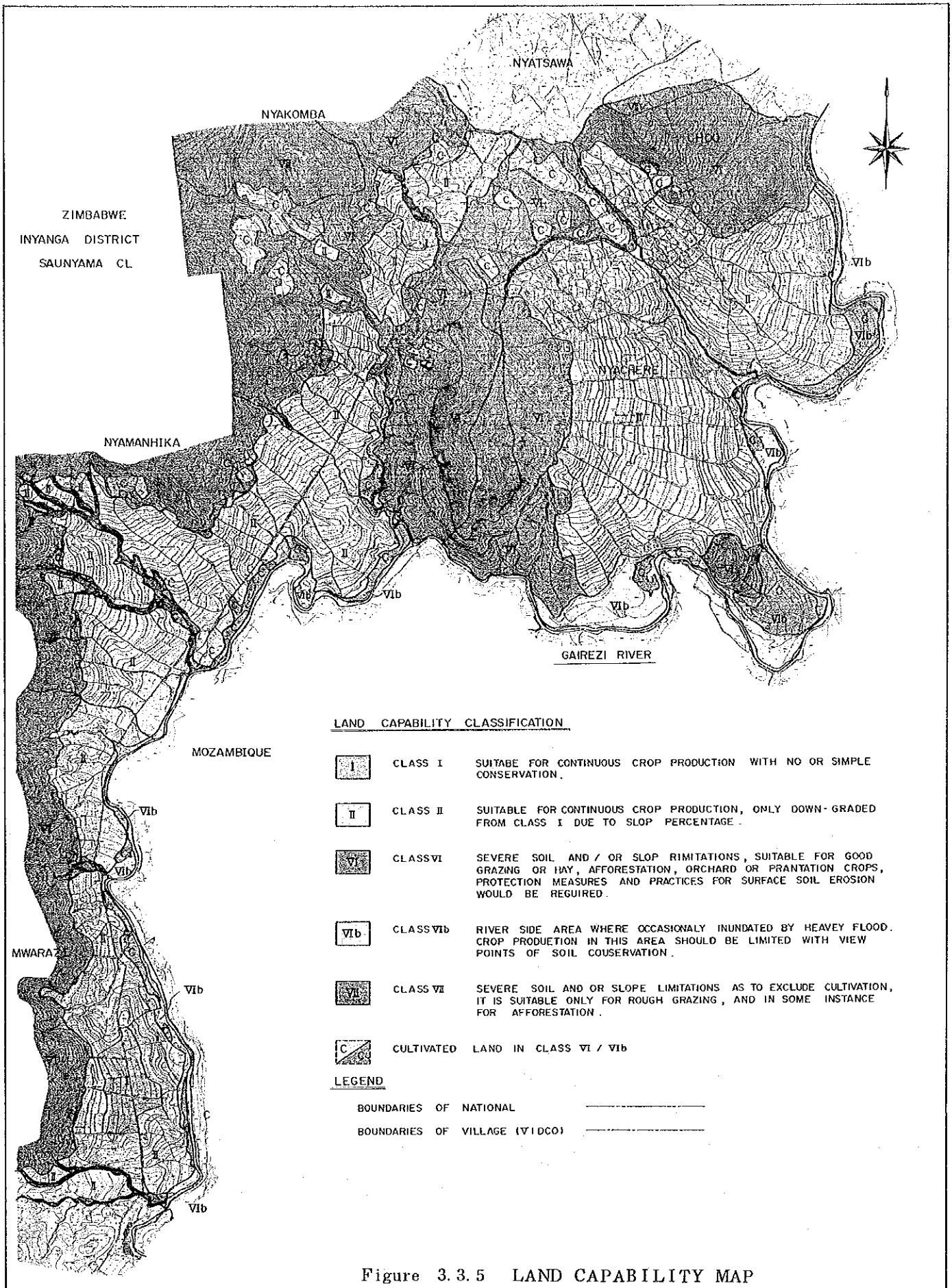


Figure 3.3.5 LAND CAPABILITY MAP

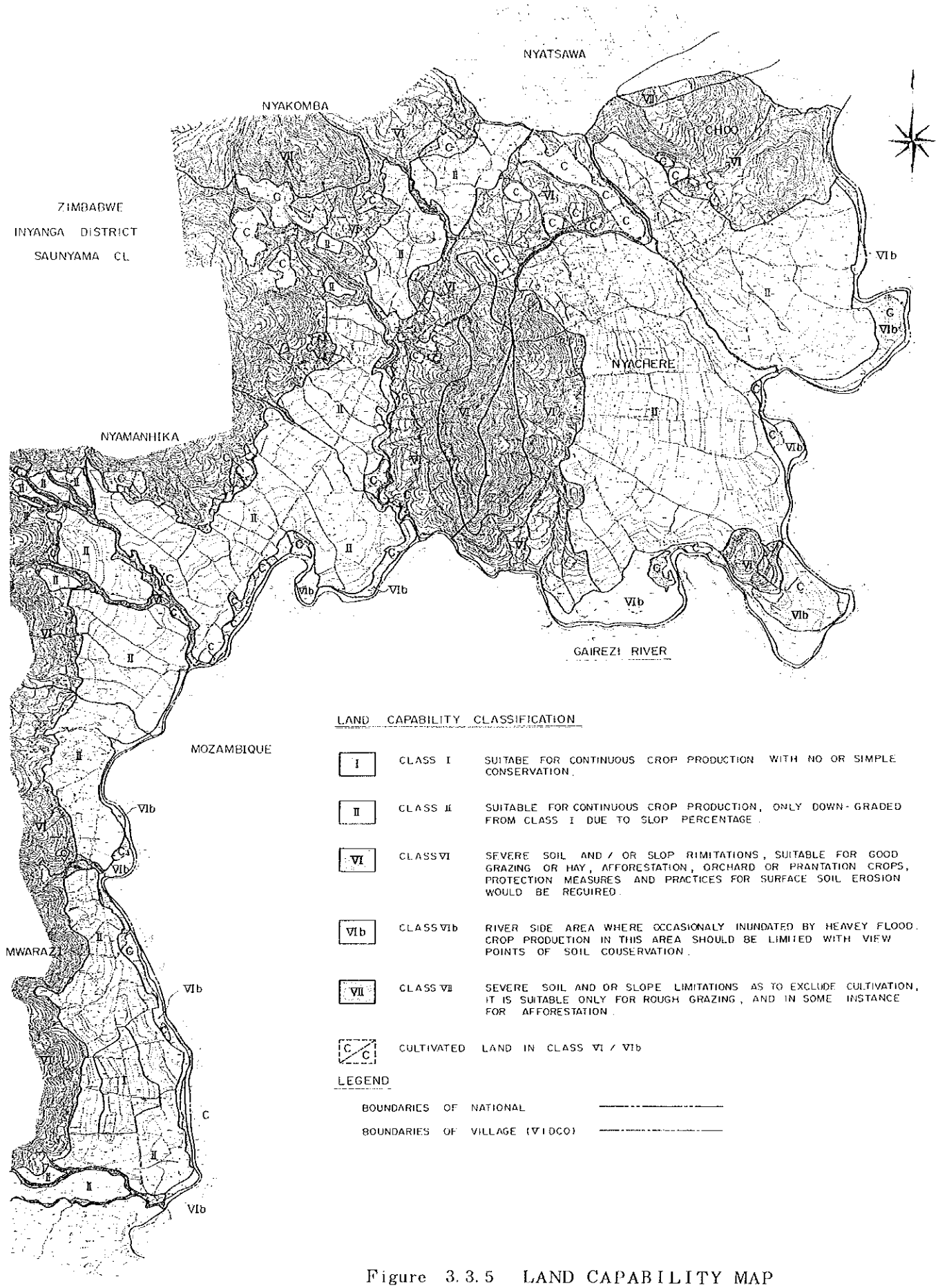


Figure 3.3.5 LAND CAPABILITY MAP

3.4 Present Land Use and Agriculture

3.4.1 Land Use

(1) Approach

In order to gain an understanding of the present land use situation and the social aspects of the study area, information was collected from existing studies by AGRITEX staff, Extension Workers in Nyakomba Ward and Nyamaropa Irrigation scheme as well as from the farmers themselves.

From topographic maps, various natural conditions such as cultivated land, grazing areas, rivers and drainage, social aspects, traffic conditions etc. were observed in the study area.

When a basic understanding was gained, interviews to VIDCO's chairmen from six villages were held to receive information about each village in categories such as agriculture, grazing, livestock, living condition and other social aspects.

(2) General

The topography of the ward is characterised by a major mountain range.

There is Chitowa hill on the eastern part of the Nyakomba township and Mazumbarange that runs East to West. The low lying areas near the mountain's skirt are characterised by fairly flat arable planes paralleling the Gairezi river.

The lowest altitude of the plan is aound 800 meters and the highest mountain peak area is 1,350 metres. The arable lands in the area mostly in the 800 meters to 850 metres ranges. The above 850 m, the mountain slopes are covered with savannah trees and the slope are mostly steep and can easily erode with to the grazing through out the year. Villages are extended along the mountain fringe area. Fig. 3.4.1 is shows the Land use in the study area.

(3) Population and Household

The population in the study area is 3,559 persons in 1989. According to age the study area is comprised of a population of children under the ages of 10 years and 10 to 15 years are 29 percent and 35 percent of the population respectively, and 65 percent is under the age of 15 years, while adults over

the age of 64 years is 9 percent. The remaining 27 percent of the population consist of adult usually countable as a labour force. Age distribution and the number of households in the villages are shown in Tabel 3.3.2.

Total households in the study area is 618 and average household size ranges form 5.2 to 6.3 persons per household. 83% of the households hold cultivated land in the range of 1.0～2.0 ha, and 14% of them hold less than 1.0 ha. No household is landless farmer. A Summary of Village's profile is shown in Table 3.4.1.

Table 3.4.1 SUMMARY OF VILLAGES

Description	2	3	4	5	6	Total or Average
Area (ha)	727	790	885	855	897	4,154
Population (1989)	638	721	807	756	637	3,559
Households	108	115	140	130	125	618
Average size of H/H	6.04	6.28	5.72	6.50	5.20	5.83
Population density (/ha)	0.88	0.91	0.91	0.88	0.71	0.86
Area under cultivation (ha)	225	202	255	221	239	1,142
Average holding of cultivated land (ha)	2.08	1.76	1.82	1.70	1.91	1.85
Range of land-holding						
5.0-3.0 ha/household	2	-	-	-	-	2
3.0-2.0	3	-	-	11	-	14
2.0-1.5	80	90	85	100	5	360
1.5-1.0	20	15	15	10	95	155
less than 1.0	3	10	40	9	25	87
without land	-	-	-	-	-	-

Source: AGRITEX Nyanga, Extension Worker.

(4) Crop Production

The study area lies in Natural Region III which is characterized by fairly severe mid-season dry spells. These mid-season dry spells render the are marginal to a production system based on entirely dry land crop production. In conformity with these natural factors, mixed type farming based on livestock and cash crop production under good management is recommended. The study area is

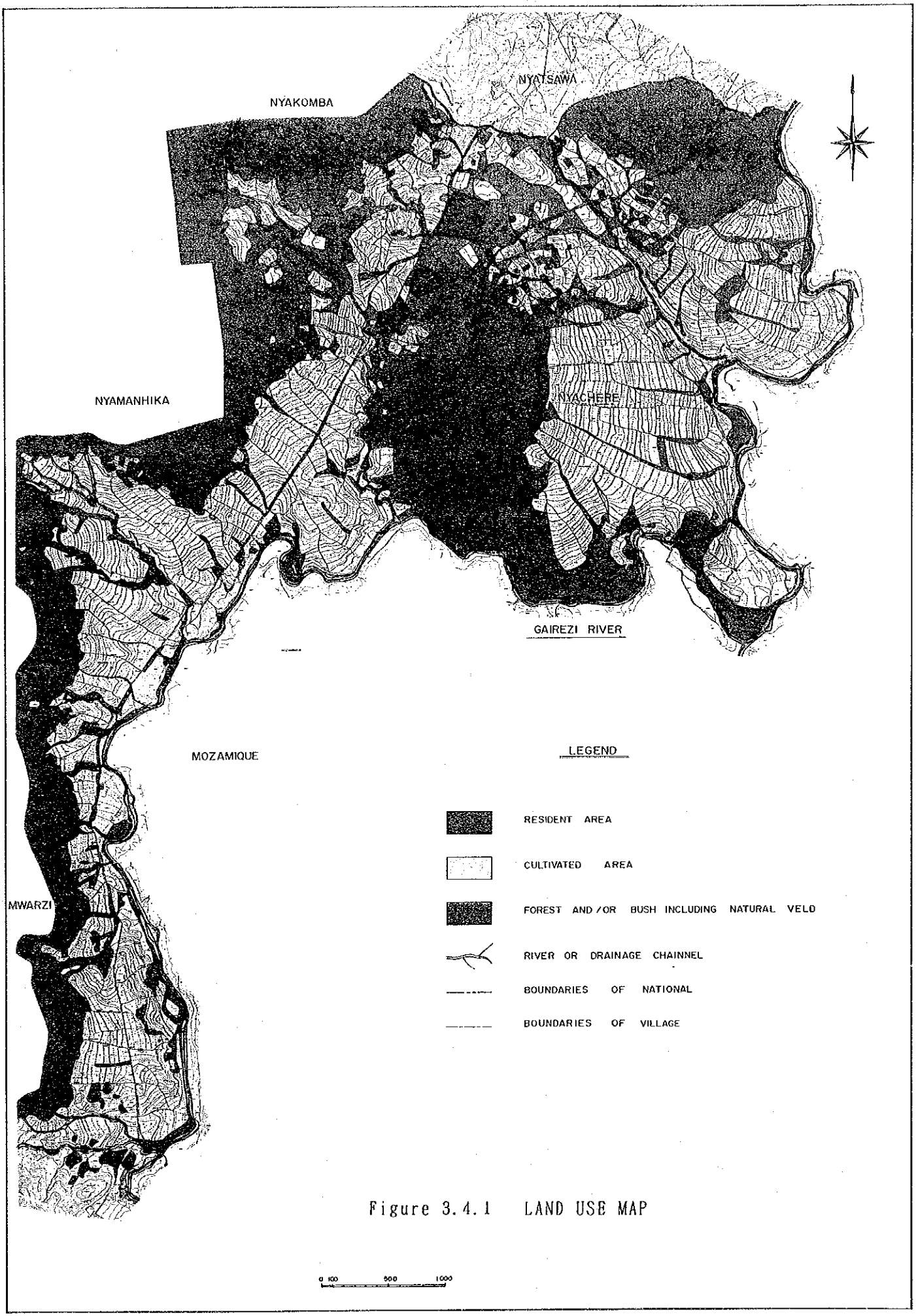


Figure 3.4.1 LAND USE MAP

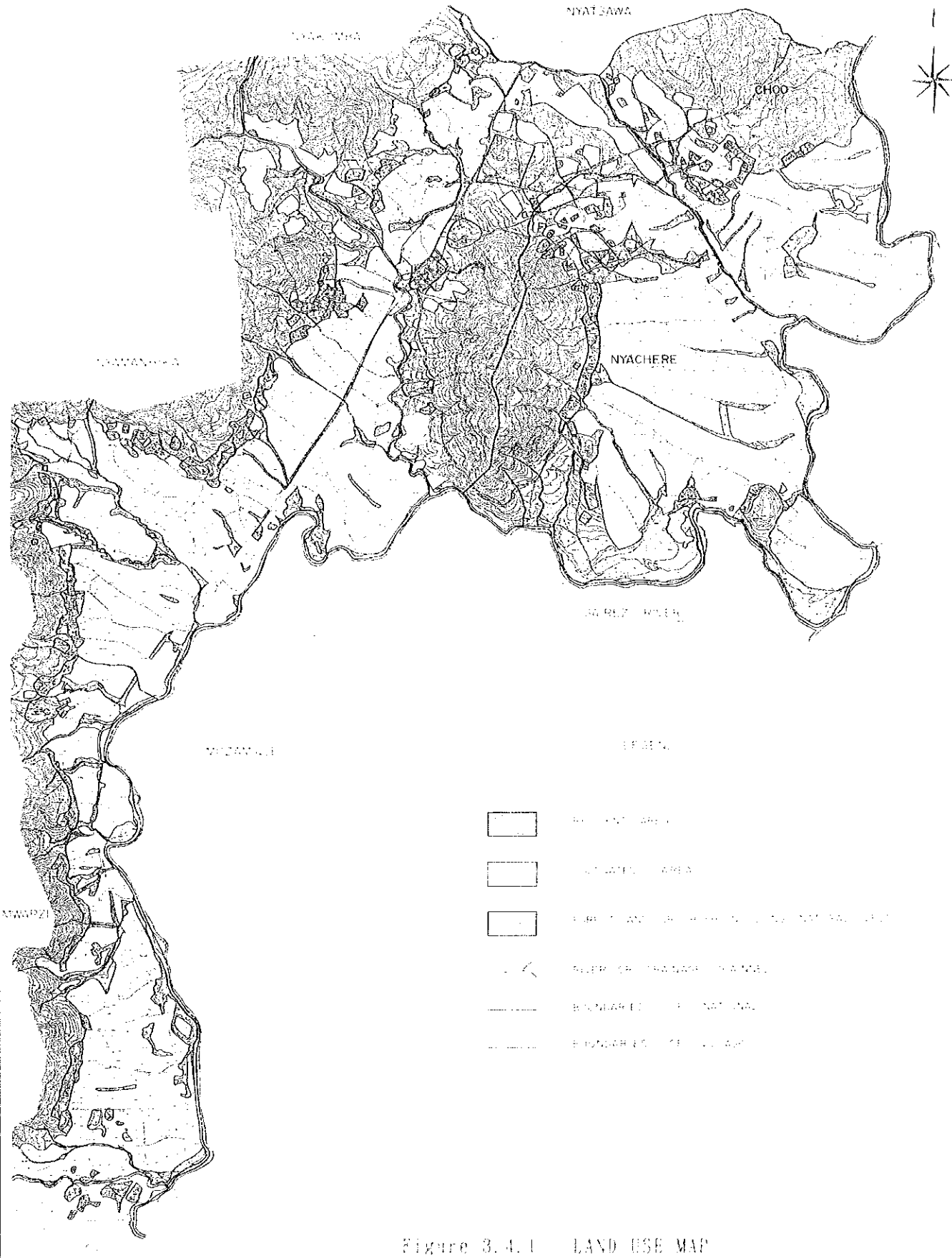


Figure 3.4.1 LAND USE MAP

marginal for maize, tobacco and cotton production. In the study area, Maize and cotton are produced as major crops, sharing about 54 and 40 percent of total cultivated area respectively.

Remaining 6 percent of cultivated land is planted with other crops, such as tobacco, sunflower, sugar beans, groundnuts, soya beans etc.

A 4.8 hectare coffee plantation was personally developed in the Nyakomba Village, which is classified as land class VI and is drip irrigated, under water right.

(5) Livestock

Livestock in the study area is cattle and goat. About 1,160 heads of cattle and 690 heads of goat are bred. A breakdown of these figures is shown in Table 3.4.2.

About 40 percent of farmers own cattle in accordance with a sampling survey from an Extension Worker.

Table 3.4.2 LIVESTOCK BY VILLAGE

Village No.	Name	Oxen	Cow	Bulls	Heifers	Calves	Total	Goat (herd)
2.	Nyakomba	64	51	21	36	16	188	125
3.	Choo	91	49	15	43	37	235	136
4.	Nyachere	102	87	19	28	39	275	91
5.	Nyamanhika	89	51	12	36	39	227	126
6.	Mwarazi	113	61	8	21	33	236	213
	Total	459	299	75	164	164	1,161	691

Source: Research by Extension Worker, 1990

(6) Grazing

There is no pastures or reinforced veld in the study area, only natural velds provide grazing for livestock. Veld grazing is very limited to mountain sides.

About 2,700ha of land in the study area are utilized as a grazing area, but the carrying capacity for livestock is poor, estimated carrying capacity in the Ward's Development Plan is 9 to 11 hectares per livestock unit (one livestock unit is equivalent to 500kg). However, the grazing area must be holding about three times that livestock units.

Poor grazing is worsened by bush encroachment, partly as result of indiscriminate cutting of timber for poles and firewood.

The grazing degradation has occurred on the relatively gentle-sloped mountain skirt areas beside or in the occupied area of a villager's homestead, some areas were exposed the mother or fragmented rock by surface erosion.

A summary of Grazing in the study area is shown in Table 3.4.3.

Table 3.4.3 GRAZING SUMMARY PER VILLAGE

Description	2	3	4	5	6	Total or Average
Households (H/H)	108	115	140	130	125	618
Grazing Area (ha)	518	491	472	610	620	2,711
Estimated carrying Capacity (LUs)	57.5	44.6	42.9	67.8	68.9	281.7
Cattle No. (LU)	122	153	179	148	153	755
Goat No. (LU)	13	14	10	13	22	72
Total LU Equivalent	135	167	189	169	175	827
Existing stocking rate ha/LU	3.84	2.94	2.50	3.79	3.55	3.28

Note: 1) Source of grazing area and estimated carrying capacity is Ward development Plan, July 1989,
2) LU means Livestock Unit, and
3) Livestock Equivalent for Cattle and Goat is applied 0.65 and 0.10 respectively.

3.4.2 Agriculture

(1) Farming Scale

The study area lies in Natural Region III which is marginal for planting maize, tobacco and cotton under natural (non irrigated) conditions. The area's planted with principal crops with the study area are shown in Table 3.4.4.

Table 3.4.4 AREA'S PLANTED TO PRINCIPAL CROPS

Crops	Planted Area by Village					Total Area	Ratio of Area
	Nyakomba (ha)	Choo (ha)	Nyachere (ha)	Nyamanhika (ha)	Mwarazi (ha)	(ha)	(%)
1 Maize	124.6	109.7	140.0	124.3	121.3	619.9	54.30
2 Cotton	87.2	83.5	97.9	85.1	103.1	456.8	40.02
3 Tabacco	2.8	-	-	5.6	6.5	14.9	1.31
4 Wheat *	-	-	-	-	-	-	-
5 Sugar beans **	0.1	0.6	2.3	0.2	0.1	3.3	0.29
6 Sugar beans *	-	-	-	-	-	-	-
7 Soya beans	0.5	-	-	-	-	0.5	0.04
8 Groundnuts	0.7	-	1.9	1.1	0.7	4.4	0.39
9 Sunflower	4.7	7.8	12.8	4.6	7.0	36.9	3.23
10 Coffee	4.8	-	-	-	-	4.8	0.42
Total	225.4	201.6	254.9	220.9	238.7	1,141.7	100.00

Note : 1) Tobacco = Air-cured tobacco,
2) * = Winter crop, 3) ** = Late summer crop, and
4) Source = AGRITEX 1985-86 to 1987-88.

The total planted area of 1,141ha is cropped with maize (54%), cotton (40%) and other crops (6%). These crops are grown only in the summer (rainy) season. In the dry season, winter crop(s) are not grown in the study area because no irrigation facilities are available. The planted area are not much different among the villages. In addition, these villages have several kinds of vegetable products in their gardens but production is small in quantity and

these use for home consumption by the villagers.

(2) Crop Production and Average Yield

The crop production per year and the average yield in the study area are shown in Table 3.4.5, and futher details are shown in ANNEX Table D.1.1 and D.1.2.

Table 3.4.5 CROP PRODUCTION AND AVERAGE YIELD

Crops	Area (ha)	Production (t)	Average Yield (kg/ha)
1. Maize	619.9	1,742.9	2,800
2. Cotton	456.8	666.1	1,462
3. Tobacco	14.9	14.138	941
4. Sugar beans	3.3	3.708	1,082
5. Soyabeans	0.5	0.543	1,138
6. Groundnuts	4.4	2.311	620
7. Sunflower	36.9	37.725	963
8. Coffee	4.8	5.317	1,085
Total	1,141.5		

Note : Source = AGRITEX 1985-86 to 1987-88.

There is no creat difference in the average crop yields among the villages. The crop yields are usually low because of low farmer inputs, the lack of draught power, and seasonal rainfall fluctuation patterns under rainfed conditions.

(3) Cropping System

In the study area, all the planted areas are single cropping systems in the summer season (rainy season). Therefore, in the winter season (dry season) the study area is left fallow.

The major cropping systems in the study area are shown in Table 3.4.6. As seen in this table, the major cropping systems types are : Maize-Cotton (2 crops with a 2 year rotation) and Maize-Sunflower-Cotton (3 crops with a 3 year rotation), each system occupies 65 and 25% of the total planted area, respectively. These two types of cropping systems occupy 90% of the total area.

Table 3.4.6 ONGOING CROPPING SYSTEM

Type	Cropping System			Coverage
	1985-86	1986-87	1987-88	Percentage(%)
I	Maize	Cotton	Maize	65
II	Maize	Sunflower	Cotton	25
III	Sugar bean	Maize	Cotton	5
IV	Sunfolwer	Cotton	Maize	5

Note : Souace = AGRITEX 1985-86 to 1987-88.

(4) Cropping Calender

The ongoing cropping calender of principal crops is shown in Table 3.4.7.

Table 3.4.7 ONGOING CROPPING CALENDER

Crops	Sowing time		Havesting time		Growth duration (day)
	Earliest	Last	Earliest	Last	
1. Maize	L.Oct.	L.Nov.	M.Mar.	M.Apr.	140-160
2. Cotton	E.Oct.	E.Nov.	L.Mar.	L.May.	180-200
3. Sugar beans	M.Jan.	E.Feb.	E.Apr.	L.Apr.	80-90
4. Sunflower	L.Nov.	L.Dec.	L.Mar.	L.Apr.	110-120
5. Tobacco	E.Nov.	L.Dec.	M.Mar.	L.Apr.	120-130

Note : 1) E.=Early, M.=Medium and L.=Late,
2) Sugar beans = Late summer crop, 3) Tobacco = Air-cured, and
4) Source = AGRITEX 1985-86 to 1987-88.

(5) Investigation of the Present Agricultural Situation

This investigation is intended to clarify the present agricultural situation in the study area in connection with the proposed irrigation scheme.

Five villages in the Nyakomba ward were selected for investigation ; these are the Nyakomba, Choo, Nyachere, Nyamankika and Mwarazi. As for farming

economy, a crop and cropping system investigation by using a quiestinnaires was distributed to ten farmers per village, thus fifty farmers in total. The date analysis, was split into 2 large farmers (over 2ha) and small farmers (under 2ha) were separately computed.

The results of this investigation are shown in ANNEX Table D.2.1 to D.2.28.

(6) Comparison of the Study Area and the Irrigated Area

During the Phase II Study, supplemental interview surveys were done with nine farmers on the upper level of the study area (non-irrigated) and two farmers in an irrigated area (Nyamaropa Irrigation Scheme) in early February, 1990.

The comparative data of these areas such as agricultural inputs and yields per principal crop are shown in Table 3.4.8 ~ 3.4.16.

As a result, the yields of principal crops in the irrigated area were superior to those of the study area in all cases. Espccially winter crop wheat which was only grown in the irrigated area. Therefore, irrigation is essential for the improvement of crop production.

3.4.3 Farm Economy

(1) Market Price of Agricultural Input

1) Seeds

Seeds for grain, cotton and tobacco are supplied to farmers through farmer's cooperatives, the Cotton Marketing Board (CMB) and the Tobacco Marketing Board (TMB), respectively ; the seed prices of the major crops are shown in Table 3.4.9. It should be noted that communal farmers are exempted from sales tax on seeds.

Vegetable seeds are supplied by the farmer's cooperatives and private seedcompanies ; the prices are not controlled by the government.

2) Fertilizers and Chemicals

The various fertilizers and chemicals are marketed through the farmer's and other private suppliers. The prices of major fertilizers and chemicals are shown in Table 3.4.12. Communal farmers are also exempted from fertilizer salestaxes.

3) Machinery and Equipment

The prices for various machinery and equipment are listed in Table 3.4.13.

4) Labour Wage

Skilled and unskilled labourers are currently hired during the busy farming season and the average rates per day are Z$5.75 for the skilled and Z$3.75 for the unskilled.

(2) Market Price of Agricultural Output

The producer's price for grain, cotton and tobacco are controlled by the Grain Marketing Board (GMB), the Cotton Marketing Board (CMB) and the Tobacco Marketing Board (TMB), respectively. The producer's prices in 1989/1990 are summerized in Table 3.4.14. On the other hand, the vegetable and fruit prices are free market price.

(3) Farm Economy of Model Farm

Model farms were analysed from eight farmers taken from the date of the interview survey in February, 1990 in the study area. The results of these figures are shown in Table 3.4.15 and 3.4.16.

3.4.4 Agricultural Supporting Survices

(1) Financial Institutions

The financial support to communal farmers is essential to improve their agricultural production and economic situation.

In the study area, there are no banks, but a branch office of the Agricultural Finance Corporation (AFC) in Nyanga is extending financial services to the communal farmers. The AFC's loan disbursements to communal farmers in Nyakomba are shown in Table 3.4.17. The interest raes for the AFC loans were decided at 9.78% per year for communal farmers.

(2) Marketing

There are five government-controlled marketing boards in Zimbabwe ; these are the Grain Marketing Board (GMB), the Cotton Marketing Board (CMB), the Cold Storage Commission (CSC), the Dairy Marketing Board (DMB) and the Tobacco Marketing Board (TMB).

1) Grain Marketing Board (GMB)

The GMB trades in grains at government prices for maize, sorghum, wheat, groundnuts, soyabeans, edible beans (Sugar beans), sunflower and coffee.

In the study area, there are four authorized government agents for grains;

grains produced by farmers are generally sold to these agents. These authorized agents transport grains from farmgates to the Nyanga GMB depot, which is approximately 70km away from the study area.

2) Cotton Marketing Board (CMB)

The CMB deals with cotton at government prices according to quality grades. The farmer's produced cotton in the study area is sold to the CMB sub-depot in the Nyamaropa center, which is approximately 10km away from the Nyakomba village,and the cotton is delivered from the Nyamaropa CMB sub-depot to the Mutare CMB main-depot by governmental and/or private transporters.

3) Tobacco Marketing Board (TMB)

The TMB deals with tobacco leaves direct from producer farmers. The prices are decided by auctioning at the Harare Tabacco Auction Floor which is managed by the TMB.

The produced tobacco is directry transported to the Harare Tobacco Auction Floor, which is approximately 340km away from the study area. The Mutare Tobacco Auction Floor will open in May 1990, which is approximately 170km away from the study area.

4) Vegetable Market

There are vegetable and fruit markets in the several towns and cities, for instance Nyanga, Mutare and Harare. The price is decided by auctioning at individual markets. The government does not control vegetable and fruit prices; therefore the prices frequently flactuate depending on market conditions.

On the other hand, the transportation from farmgates to the markets is difficult for individual farmers. It should be necessary to coordinate marketing activities with the initiative of the farmer's association.

(3) Farmers Association

There are three farmer's associations in Zimbabwe ; the Commercial Farmers Union (CFU), the Zimbabwe National Farmers Union(ZNFU) and the National Farmers Association of Zimbabwe (NFAZ). Those are organized by commercial farmers (over 1,000ha), small commercial farmers (under 1,000ha) and communal farmers, respectively.

The activities of NFAZ are to supply communal farmers with the in

agricultural inputs such as seeds, fertilizers, chemicals, livestock feeds and agricultural instruments, as well as extending marketing services for the outputs.

There are two NFAZ club committees in the study area, these NFAZ clubs are active units in the villages, therefore the other three villages have no NFAZ clubs.

(4) Agricultural Extension

In Zimbabwe, agricultural extension activities are extended by the Department of Agricultural Technical and Extension Services (AGRITEX), backed up by the Department of Research and Specialist Services (DR & SS). Both these departments belong to the Ministry of Lands, Agriculture and Rural Resettlement (MLARR).

AGRITEX provides advice to farmers on the subjects of crop cultivation, livestock raising and the conservation of soil and other natural resources. The DR&SS provides services in the fields of soil analysis, and the identification and control of weeds, pests and diseases. The experiments for breeding crops/varieties are carried out with the aim of producing higher yielding varieties. The Department of Veterinary Services is concerned with animal health. The services offered include identification and control of animal diseases, in particular the tsetse-fly and tick-borne diseases.

The AGRITEX Nyanga Regional Office is providing extension activities in the study area ; this office has over ten extension officers. About half of the staff members of the Nyanga Regional Office reside at the Nyamaropa Irrigation Office, that is approximately 15km away from the study area.

Table 3.4.8 CROP PRODUCTION PER YEAR BY VILLAGE (t)

Crops	Production by Village					Total Production
	Nyakomba	Choo	Nyachere	Nyamanhika	Mwarazi	
1 Maize	367.9	270.3	388.0	356.5	360.2	1,742.9
2 Cotton	136.0	106.7	127.5	130.5	165.4	666.1
3 Tobacco	2.600	-	-	5.260	6.278	14.138
4 Wheat*	-	-	-	-	-	-
5 Sugar beans**	0.142	0.690	2.548	0.182	0.146	3.708
6 Sugar beans*	-	-	-	-	-	-
7 Soyabeans	0.534	-	-	-	-	0.534
8 Groundnuts	0.420	-	1.195	0.280	0.416	2.311
9 Sunflower	4.318	7.146	11.260	4.662	7.339	34.725
10 Coffee	5.317	-	-	-	-	5.317

Note : 1) * = Winter crop, 2) ** = Late summer crop, and
3) Source = AGRITEX 1985-86 to 1987-88.

Table 3.4.9 AVERAGE YIELD BY VILLAGE (kg/ha)

Crops	Average Yield by Village					Average Yield
	Nyakomba	Choo	Nyachere	Nyamanhika	Mwarazi	
1 Maize	2.930	2.470	2.760	2.870	2.970	2.800
2 Cotton	1.555	1.267	1.350	1.533	1.605	1.462
3 Tobacco	917	-	-	933	973	941
4 Wheat*	-	-	-	-	-	-
5 Sugar beans**	1.062	1.084	1.065	1.111	1.099	1.084
6 Sugar beans*	-	-	-	-	-	-
7 Soyabeans	1.138	-	-	-	-	1.138
8 Groundnuts	600	-	640	610	630	620
9 Sunflower	908	1.013	1.023	940	930	963
10 Coffee	1.085	-	-	-	-	1.085

Note : 1) * = Winter crop, 2) ** = Late summer crop, and
3) Source = AGRITEX 1985-86 to 1987-88.

Table 3.4.10 AREA, INPUT AND FIELD OF PRINCIPAL CROPS
IN THE STUDY AREA AND IRRIGATED AREA (1988/89)

	Maize		Cotton		Sugar beans		Tobacco		Wheat	
	Study Area	Irrig. Area	Study Area	Irrig. Area	Study Area	Irrig. Area	Study Area	Irrig. Area	Study Area	Irrig. Area
Planted Area (ha)	0.98	0.25	0.92	1.15	0.55	1.60	0.60	0.50	-	0.40
Seeds (/ha)	24kg	22kg	20kg	21kg	118kg	126kg	16g	12g	-	122kg
Fumi Chem, * (1/bed)	-	-	-	-	-	-	4.5	2.2	-	-
Seedbed Fert. ** (kg/bed)	-	-	-	-	-	-	33	48	-	-
Seedbed Chem, *** (1/bed)	-	-	-	-	-	-	0	0.03	-	-
Manure (t/ha)	2.4	0	0.5	0	0	0	0	0	-	0
Basic Fert. ** (kg/ha)	212	387	243	421	233	396	416	750	-	375
Topdress Fert. ** (kg/ha)	127	250	130	96	108	171	333	300	-	250
Chemicals,wp (kg/ha)	0	0	6.3	10.3	0.6	0.6	0	0	-	0
Chemicals,ec (1/ha)	0	0	2.0	2.5	0	0	2.7	4.0	-	0
Labours (man-day/ha)	125	108	135	116	60	71	198	189	-	83
Yield (t/ha)	3.86	5.01	1.74	3.04	0.74	1.29	1.87	2.90	-	3.30
Ratio of yield (%)	100	130	100	175	100	174	100	155	-	-

Cultivated Land (hectare per household) Study area; 2.69 Irrigated areal 2.00

Note: 1) * = Fumigation chemicals, 2) ** = Fertilizers, 3) *** = Chemicals, and
4) Source = Interview data, Feb. 1990.

Table 3.4.11 SEED PRICE

Items	Variety	Prince (Z$) Including tax	Price (Z$) Less tax
Maize	SR 52 (White)	6.50/2kg	5.78/2kg
Sunflower	Msasa	27.00/5kg	24.00/5kg
Groundnuts	Spanish	24.19/10kg	21.50/10kg
Sugar beans	Standard	3.60/kg	3.20/kg
Soya beans	Roan Quiber	49.50/50kg	44.00/kg
Cotton	Standard	0.21/kg	0.19/kg

Note: Source = Interview data, Feb. 1990.

Table 3.4.12 PRICE OF FERTILIZERS AND CHEMICALS

Items	Price (Z$) Including tax	Price (Z$) Less tax
Compound B (4, 17, 15, 0.1)*	36.15/50kg	32.13/50kg
Compound C (6, 17, 15, 0.1)*	36.20/50kg	32.18/50kg
Compound D (8, 14, 7, 0)*	28.75/50kg	25.56/50kg
Compound L (5, 18, 10, 0.25)*	32.61/50kg	28.99/50kg
Compound M (10, 10, 10, 0)*	28.41/50kg	25.25/50kg
Compound S (6, 17, 6, 0.04)*	35.25/50kg	31.33/50kg
Ammonium Nitrate (34.5%N)	29.88/50kg	26.56/50kg
Single Super phosphate (18.5%P_2O_5)	22.60/50kg	29.09/50kg
Double Super phosphate (37%P_2O_5)	41.12/50kg	36.55/50kg
Thiodan	26.95/kg	
Carbaryl	22.95/kg	
Rogor	12.95/500ml	
Agrithrin	51.95/500ml	
EOB	285.00/20l	

Note: 1) * = Percentage of nitrogen, phosphate, potash and borun, respectively, and 2) Source = Interview data, Fab. 1990.

Table 3.4.13 PRICE OF MACHINERY AND EQUIPMENT

Items	Unit Price (Z$)
Hoe	5.25
Sickle	8.95
Wheel barrow	159.95
Plough	117.95
Cultivator	189.50
Grain bag	2.50
Napsack Sprayer	200.00
Scotch cart, long-bed	600.00
Scotch cart, short-bed	350.00

Note: Source = Interview data, Feb. 1990.

Table 3.4.14 PRODUCER'S PRICE

Items	Grade	Price (Z$/t)	Items	Grade	Price (Z$/t)
Maize (white)	A	215.00	Wheat	AS	400.00
	B	212.80		BS	396.90
	C	210.50		CS	393.80
	D	186.60		DS	384.60
				U	300.00
Sugar beans	A	450.00	Soya beans	A1	461.79
	B	420.00		1	456.75
				BB	435.00
				C	395.20
Groundnuts	A1	1,000.00	Sunflower	AA	455.00
	A2	981.00		BA	432.25
	A3	963.00		CA	372.00
	A4	944.50			
Cotton	A	925.00	Tobacco	STD-B1	6,000.00
	ASS	920.00		STD-B3	6,800.00
	B	860.00		STD-B5	7,000.00
	CC	840.00		STD-B7	6,100.00
	D	730.00		STD-B9	4,500.00

Note: Source = GMB, CMB and TMB, 1989-90.

Table 3.4.15 AGRICULTURAL INPUT AND OUTPUT IN THE MODEL FARM

Item		Maize	Cotton	Sugar beans	Ground-nuts	Sun-flower	Tobacco	Total
Planted area	(ha)	0.963	0.725	0.025	0.025	0.075	0.075	1.888
Production	(t)	3.293	1.202	0.017	0.020	0.072	0.140	
Family consumption	(t)	1.150	-	0.010	0.020	0.003	-	
Sale quantity	(t)	2.143	1.202	0.007	0	0.070	0.140	
Sale price	(Z$)	455.98	1033.29	2.84	0.00	30.04	953.70	2475.84
Quantity of input								
Seed	(kg)	22.88	15.00	3.00	1.25	3.75	1.25(g)	
Fertilizer								
Compound D	(kg)	175.25	-	4.13	-	-	-	
Compound L	(kg)	-	164.00	-	-	-	-	
Compound S	(kg)	-	-	-	-	18.75	2.50	
Compound B	(kg)	-	-	-	-	-	31.25	
Ammonium Nitrate	(kg)	125.25	92.50	4.13	1.25	-	25.00	
Manure	(t)	2.77	0.37	-	-	-	-	
Chemical								
Thiodan	(kg)	-	2.625	0.025	-	-	-	
Carbaryl	(kg)	-	2.125	-	-	-	-	
Rogor	(l)	-	0.863	-	-	-	0.200	
Agrithrin	(l)	-	0.675	-	-	-	-	
EDB	(l)	-	-	-	-	-	0.338	
Price of input								
Seed	(Z$)	66.11	2.85	1.35	2.69	18.00	2.50	93.50
Feetilizer	(Z$)							383.39
Compound D	(Z$)	89.59	-	2.11	-	-	-	
Compound L	(Z$)	-	95.09	-	-	-	-	
Compound S	(Z$)	-	-	-	-	11.75	1.57	
Compound B	(Z$)	-	-	-	-	-	20.08	
Ammonium Nitrate	(Z$)	66.53	49.14	2.19	0.66	-	13.28	
Manure	(Z$)	27.70	3.70	-	-	-	-	
Chemical	(Z$)							222.66
Thiodan	(Z$)	-	70.74	0.67	-	-	-	
Carbaryl	(Z$)	-	48.77	-	-	-	-	
Rogor	(Z$)	-	22.35	-	-	-	5.18	
Agrithrin	(Z$)	-	70.13	-	-	-	-	
EDB	(Z$)	-	-	-	-	-	4.82	
Total price of input	(Z$)	249.93	362.77	6.32	3.35	29.75	47.43	699.55

Note: Source = Interview data, Feb. 1990.

Table 3.4.16 NUMBER OF FAMILY AND FARM WORKER IN THE MODEL FARM

Age	No. of family	Farm Worker	Other worker
15-64 year	3.375	2.375	1.000
Over 65 year	0.375	0.188	-
10-14 year	1.750	0.875	-
Under 10 year	2.000	-	-
Total	7.500	3.438	1.000

Note: Source = Interview data, Feb. 1990.

Table 3.4.17 AFC LOAN DISBURSEMENT IN NYAKOMBA (1989/90)

Item	Number of farmer	Amount (Z$)	Average (Z$)
Granted loan	129	64,621	500.94
Outstanding loan	129	42,040	325.89
Average in the Study Area	618	-	68.03

Note: Source = AFC Manicaland, Feb. 1990.

4. THE PROJECT

4. THE PROJECT

4.1 Basic Concept of Development Plan

(1) This "Nyakomba Irrigation Development Project" has the role of a pilot project for the integrated rural development of Communal Land. Traditional subsistence farming on communal Land should gradually be improved to a commercial based agriculture. For this reason the introduction of an effective irrigation system and the diversification of profitable crops as well as the application of improved technology will be indispensable.

Therefore, it is neccessary that the Projects plans be adaptable to other Communal Lands.

(2) On the Nyakomba Irrigation Project, AGRITEX has already carried out some surveys and studies, that is a land classification map, a land use map, survey of irrigable areas and other data were available for the JICA F/S.

This data, was very useful being that 75 irrigation development projects were carried out by AGRITEX located country wide. The Study Team has utilized them, especially to determine the standard level construction costs, materials, and methods in the country at present.

Data and information from the Nyamalopa Irrigation Project, which is located at about 5 Km south of the study area and was completed by AGRITEX, were also utilized for the JICA F/S.

(3) The basic development concept will be formulated as to well adapt to the present status and future perspectives of the natural, social and economic conditions in Zimbabwe and the study area, taking into account the agricultural and rural development policy of the Government of Zimbabwe.

(4) For the successful execution of irrigated agriculture measures such as technical extensions and marketing systems need to be established. In planning, stress will be placed upon lowering costs and employing technology appropriate for a smooth construction, maintenance and operation in the future.

(5) To support the farmers, it is requested to set up extension services and of cooperative activities, moreover to construct farm roads and domestic water supply systems.

(6) It is important to make an implementation schedule and determine the financial sources for construction work.

(7) WATER SOURCES; The water source for irrigation and domestic-use, will come from the Gairezi River with pumping stations, after being compared with the Nyakomba River Dam, because of it's low cost and the short construction period, moreover it is unavoidable to adopt the pumping station method in many communal areas located on flat land.

(8) IRRIGATION SYSTEM; The equipment required from the water source to each field, is as follows:

Pumping station (water source structure)
⇩
Pipeline (water delivery)
⇩
Control reservoir (water storing and outlet cotrol)
⇩
Open canal (water distribution, gravity system)
⇩
Furrow irrigation (to each plot)

(9) DEPRECIATION COST; It is recommended to save a depreciation cost for each crop year, because the machines and materials have the lmited economic life respectively, therefore, this cost is very important to replace them infuture.

(10) MACHINERY FARMING; In the project area draught powers is not enough even at present, therefore, the introduction of tractors was studied. To modernize Zimbabwe's agriculture, the introduction of machinery farming shall be unavoidable.

(11) PROJECT MANAGEMENT OFFICE; A Project Center is established, in Irrigation Block C, for the smooth management and control of the Project, includes major buildings such as the Project Management Office, warehouses, workshop, garages, training center, staff quarters, etc..

(12) PROJECT AREA; The Nyakomba ward is comprised of 6 villages, Nyatsawa, Nyakomba, Choo, Nyachere, Nyamanhika and Mwarazi in its administration.

Nyatsawa has no candidate farms to fit into the irrigation plan, therefore the other 5 villages without Nyatsawa were decided as the Project area of this plan, therefore the other 5 villages without Nyatsawa were decided as the Project Area of this plan.

4.2 Water Resources Development Plan

4.2.1 Meteorology and Hydrology Analysis

Meteorology and hydrology date analysis is carried out for the purpose of deciphering the findings from field surveys and the accumulated data on the irrigation project.

According to the analysis, it is confirmed that the Gairezi River is expected to supply enough water for the scheduled irrigation Project. The Nyakomba River is not expected to be used as a water source for the project.

The analysis results are shown below.

(1) Meteorological Analysis

1. Temperature Lapse Rate

In order to estimate the temperature in the Project area, lapse rate analysis is applied, as follows.

$$Ts = Tn + 0.81\ (Hn - Hs) / 100 = Tn + 8.6 \quad \ldots\ldots\ldots (4.2.1)$$

where, 0.81 ; coefficient by experiment
Ts ; estimated temperature of Nyakomba (℃)
Tn ; temperature of Nyanga (℃)
Hn ; elevation of Nyanga (1,878 m)
Hs ; elevation of Nyakomba (816 m)

The converted temperatures of Nyakomba are shown as follows.

(℃)

	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.
Max.	31.3	30.3	29.9	29.7	29.8	29.5	28.8	27.4	25.4	24.9	27.5	30.4
Mim.	19.1	20.1	20.8	21.4	21.1	20.0	18.2	15.6	14.0	13.9	14.8	16.5
Mean	25.2	25.2	25.4	25.6	25.5	24.8	23.5	21.5	19.7	19.4	21.2	23.5

Annual mean temperature of the Nyakomba area from 1940 to 1988, which was caluclated with the above formula, is 23.4℃.

2. Probable Rainfall

The probable rainfall per year, month, day and hour are calculated based on records from the Nyamaropa Irrigation Office. The results are shown as follows.

Probability Annual Rainfall (mm)

Item	1/3	1/5	1/10	1/20	1/50	1/100	1/200	1/500
Unexceedance	798.7	668.6	537.6	-	-	-	-	-
Exceedance	-	1,251.6	1,427.9	1,582.5	1,765.5	1,893.5	2,015.1	2,168.0
Maximum daily rainfall	-	106.5	123.2	132.0	155.9	168.6	180.7	196.3
During 60 min.	-	36.9	42.7	-	54.0	58.5	62.7	68.1
During 20 min.	-	76.8	88.8	-	112.4	121.6	130.3	141.6

As shown in this table, the value of annual rainfall which is equivalent to a value of unexceedance probability of ten years is 537.6mm. The value of annual rainfall in 1986/87 of which 557.9mm is the nearest value to 537.6mm. Therefore, the year 1986/87 is called a basic year in this plan.

(2) Hydrological analysis

A runoff analysis is carried out in the basic year on the Gairezi River and the Nyakomba River which are considered to be the main water sources for this irrigation plan. According to the analysis, estimated base flow of the Gairezi

River is 7.48m³/s, and is enough to supply the irrigation water.

The calculated annual runoff discharge at the alternative Nyakomba dam site, is assumed not to be enouugh to supply the irrigation water, even if the dam is constructed. The analysis results are shown below.

1. Estimation of the Gairezi River Base Flow

According to results from measured runoff and collected data, the Gairezi River base flow for a basic year can be estimated with the following method.

In this region, the base flow may occur in September, which is the last month of the dry season. The Base flow of the Gairezi River in a basic year can be estimated as follows.

- average water level at FGP.C-7 on September 1989 = 0.260 m ·····> 0.263 m³/s (converted by a rating table)
- average runoff for September 1987 ·····> 0.246 m³/s
- average observed runoff value of the Gairezi River ·····> 8.01 m³/s
- estimated base flow of the Gairezi River in the basic year = 8.01 x 0.246/0.263 = 7.48 m³/s

2. Base flow of the Nyakomba River

Base flow of the Nyakomba River was estimated with the same formula as above.

- observed runoff value of the Nyakomba River ·····> 8.1 lr/s (site catchment area is 23.76km²)
- dam site catchment area = 21.45 km²
- dam site runoff = 8.1/23.76 x 21.45 = 7.31 lr/s
- estimated base flow of the Nyakomba River in the basic year = 7.31 x 0.246/0.263 = 6.8 lr/s = 0.007m³/s

3. Peak runoff of the Nyakomba River

Peak runoff is a very important factor for deciding the scale and type of irrigation facilities. It is calculated with the Rational formula (4.2.2).

In Zimbabwe, peak runoff is estimated by the Loyd Davis method which has the same results as the Rational formula.

$$Qmax = 1/3.6 \cdot f \cdot r \cdot A = 0.2778 \cdot f \cdot r \cdot A \qquad (4.2.2)$$

where Q_{max} : Peak Runoff (m^3/s) f : runoff Coefficient

r : Average Rainfall Intensity in time of concentration

$= R_{24}/24 \cdot (24/T)^{2/3}$

$T = 1/w$ (hr) (4.2.3)

$w = 72 \cdot (h/1)^{0.6}$ (km/hr) (4.2.4)

where T : Flood Lag Time w : Flooding speed

l : River length between watershed and the Site (m)

h : Elevation Difference between Watershed and the Site(m)

R_{24} : Probable 24-hour rainfall

1) Calculation of Flood Lag Time

A longitudinal drawing from the watershed point to the dam site is shown below,

between A-B : $w = 72 \cdot (230/7300)^{0.6} = 9.04$

$T_1 = 7.3/9.04 = 0.81$ hr

between B-C : $w = 72 \cdot (130/2000)^{0.6} = 13.97$

$T_2 = 2.0/13.97 = 0.14$ hr

$T = T_1 + T_2 = 0.95$ hr

2) Calculation of Peak Runoff

A runoff coefficient was applied "0.70". This value is accepted for hydrological zones (decided by M.W.R) which includes the study area. Peak runoff was estimated with the above calculated values. The Calculated peak runoff is 252.4 m^3/s, 270 m^3/s of which the return periods are 100 years, 200 years and 500 years.

4. Runoff Analysis at the Alternative Dam Site on the Nyakomba River

The Nyakomba river basin, has no existing hydro-data, therefore, for this project's planning, the unit hydrograph method was adopted.

$$Qmax = 0.2778 \cdot A \cdot Ro/(0.3 \cdot T_1 + T_{0.3}) \quad \cdots\cdots\cdots\cdots\cdots\cdots \quad (4.2.5)$$

unit hydrograph up-ward curve

$0<t<T_1$: $Qa/Qmax = (t/T_1)^{2.4}$

unit hydrograph down-ward curve

$$\left.\begin{array}{ll} 1>Qd/Qmax>0.3 & : Qd/Qmax = 0.3^{(t-T1)/T0.3} \\ 0.3>Qd/Qmax>0.3^2 & : Qd/Qmax = 0.3^{(t-T1+0.5\cdot T0.3)/1.5\cdot T0.3} \\ 0.3^2>Qd/Qmax & : Qd/Qmax = 0.3^{(t-T1+1.5\cdot T0.3)/2.0\cdot T0.3} \end{array}\right\} \quad (4.2.6)$$

where, Qmax : maximum runoff of unit hydrograph

Qa, Qd : runoff in unit hydrograph for each unit time

A : catchment area T_1 : arrival time at peak runoff

$T_{0.3}$: time for decreasing runoff until 0.3 times of Qmax

T_1 : $tg + 0.8 \cdot tr$ $T_{0.3} = 0.47 \cdot (A \cdot L)^{0.25}$

tg : delayed time $= 0.21 \cdot L^{0.7}$ $(L \leq 15km)$

$= 0.40 + 0.058 \cdot L$ $(L > 15km)$

L : distance from the watershed end to the site

tr : unit time Ro : unit rainfall

According to each given value being are A=21.45 km², L=9.3 km, tr=0.5hr, and Ro=10mm, calculation results are below by function (4.2.5) and (4.2.6).

tg = 0.41 hr

$T_{0.3}$ = 1.77 hr

T_1 = 0.81 hr

Qmax = 29.6 m³/s

A unit hydrograph is drawn using this characteristic data. The runoff amount can be estimated by applying this unit hydrograph and the calculated annual runoff amount is 8,213,940 m³.

Effective rainfall was estimated as follows.

$R - Re = R\ell$, $Re = f \times R$

where R : Total Rainfall, Re : Effective Rainfall, $R\ell$: Water Loss

f : runoff coefficient for the study area = 0.7

The average duration time of rainfall on a daily basis is 4 hours which was estimated from the duration of rainfall data in January of 1984, daily

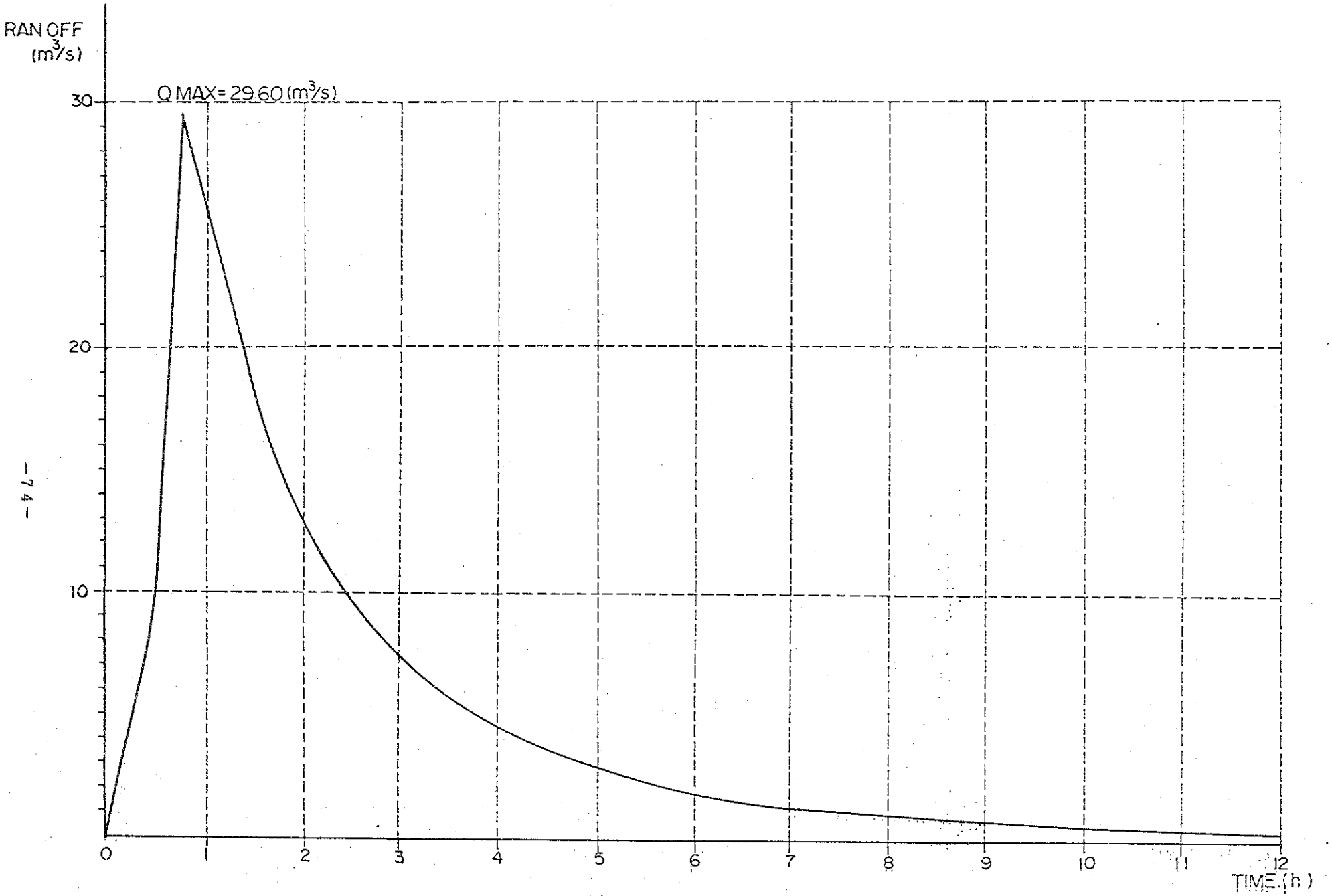


Fig. 4.2.1 UNIT HYDROGRAPH AT NYAKOMBA DAM SITE

records are summerized as follows.

Location	Date	Discharge	Remarks
		m^3/sec	
- Upper side	Sep. 13	8.31	Gauging staff No. 1
	Sep. 26	7.51	
- Lower side	Sep. 18	8.37	Gauging staff No. 2
	Sep. 26	7.82	

Judging from the above river discharge values of the Gairezi River the Gairezi River water sources are considered to be enough to irrigate the project area. But this irrigation water must be supplied from the Gairezi River to the scheduled irrigation areas by pumping systems being that the irrigation areas are located on higher portions than the Gairezi River's water surface.

(4) The Gairezi River Water Sources (Weir System)

According to the discharge analysis of the Gairezi River, it was clarified that the volume of river discharge is enough to irrigate the project area.

An alternative plan to construct a weir crossing the river was studied as follows. However, at the time of finishing of the reconnaissance survey, it was already clarified that the weir construction plan was quite impossible due to the following major reasons.

a. Relative altitude, between the river bed the irrigation area, is around 40 m, and elevation of river bed 809.5 m and irrigation area 850 m. Therefore, a 40 m high weir at least is required.

b. To select a site more up stream where the elevation would be higher than 850 m, candidate sites located 15 km away from the Project area. Therefore, pressure pipelines, 15 km long and 5.0 kg/sq.cm pressure or more, are required.

c. The right bank of Gairezi River is in the territory of Mozambique, therefore the Gairezi River is an international river, to construct a weir through into foreign territory should be avoided.

(5) The Nyakomba River Water Sources (Dam Construction)

The Nyakomba River is the largest tributary of the Gairezi River within the project area and it runs from the western mountain area to the east and flows into the Gairezi River in the central part of the project area. Also this river is a perennial river.

As stated in 4.2.1, the runoff analysis of the Nyakomba River was carried out based on rainfall data in 1986/87 which was selected as a basic year for planning. According to the results from the runoff analysis, the water resources amount from the Nyakomba River is estimated to be 8.2 million m^3 per annum. The amount of monthly run-off is shown as follows.

The Nyakomba River Monthly Runoff 1986/87 (in 1000 m^3)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Ang	Sep	Total
724.0	364.9	2,973.8	2,518.7	908.6	612.5	52.6	-	-	-	58.9	-	8,213.9

The basic flow in the dry season is observed to be seven liters per second.

The Nyakomba River water source is assumed not to be enough to supply the irrigation water to the projected area. Moreover, if a dam was scheduled to reserve runoff water, no suitable dam site could be found.

(6) Conclusion

According to the study, it was concluded to adopt the pumping stations plan in Gairezi River as the irrigation system for the Nyakomba Project.

Because, a weir system plan in the Gairezi River is too large and is too costly, and a dam construction plan in the Nyakomba River cannot store enough water and is too costly.

Therefore, pumping stations are the most suitable plan from economical and technical view point.

4.3 Land Use Plan

4.3.1 Ward Development Plan

The WARD DEVELOPMENT PLAN for Ward No.3 Nyakomba of the Saunyama Communal Land in the Nyanga District was provided on July 1989 (Ref. No. 1/7/5/3) by The AGRITEX, MANICALAND Province.

This plan aims to release problems hindering the inhabitants from realising the potential benefits of their farming systems, these problems consist mostly of man made problems other than physical or environmental nature type problems.
The improvements aimed for are :

(1) Improve conservation work,
(2) Improve the grazing areas,
(3) Control or discourage stream bank cultivation,
(4) Improve livestock off-take and available draught power,
(5) Encourage the farmers to form an irrigation group committee,
(6) Satisfy the basic human needs as complied with the Land Use Planning Policies, provide;
  (a) Clean potable water
  (b) Sanitation through the provision of blair toilets
  (c) Establishment of woodlots

And if the above objectives as outlined are met, then the following benefits can be envisaged;

(1) More agricultural and livestock production from the area,
(2) Increased resources base and self sufficiency,
(3) Increased livestock off-take thus more "invisible" benefits such as milk, manure, draught power etc.
(4) More income due to sales,
(5) Curtail erosion in the area thus a sustainable environment would prevail,
(6) Minimize overgarazing with the resultant effect of erosion prevention in the ward,
(7) Irrigation would minimize the effects of mid season droughts thus increasing crop performance and the reliability of agricultural performance, and

(8) Grazing schemes would, besides improving the livestock performance, enable farmers to concentrate on agriculture.

Both projects, the Nyakomba Irrigation Development Project (The Project), and The Ward Development Plan, have the same target by realizing the potencial benefits of the inhabitants' farming system and raising/strengthening the farmers life.

Main objective of the Project, however, is the establishment of an irrigation scheme in the project area, and to understand that the overall problems in the area can not be improved only with the implementation of the irrigation project. It is desired to execute the Ward Development Plan as early as possible.

4.3.2 Land Use Plan

(1) Irrigated Farming Area

The irrigable farming areas were selected from the study area which satisfied the following criteria.

1) Land, on Class Ⅰ or Ⅱ of the Land Capability Classifications with class Aor B for irrigation.

2) Land, not divided into small pieces of land by a hill/mountain, forest/bush, river/drainage channel and/or village, the minimum size of one piece of land for irrigation will be more than 10ha.

3) Land, not riverside cultivated land which is occasionally inundated by heavy flooding.

Five irrigation blocks with 680ha of net cultivation area, are chosen in compliance with the above criteria and technical irrigation practices view points.

(2) Dryland Farming Area

Out of 1142ha of the present cultivation area, 462ha are left non-irrigated. Several dryland farming areas, however, will get some benefits from

the Project through the improvement of farm roads, intensified cultivation technology and so forth.

Table 4.3.1 IRRIGATION AREA SCHEDULED

Block	Village Related	Acreage (ha)	
		Gross	Net
Block A	Mwarazi	128	115
Block B	Mwarazi, Nyamanhika	142	128
Block C	Nyamanhika, Nyakomba	156	140
Block D	Nyachere	226	203
Block E	Choo	104	94
Total		756	680

sourse: JICA Survey Team

(3) Grazing Area

There are definitely far too cattles for the desired carring capacity of the grazing area as refered to in the Table 3.4.3 "Grazing Summary per Village".

Some limitation on the permission for the breeding of cattle as to keep cattle numbers within desired carrying capacity will be necessary until such a time that the velds have improved. On the other hand, the introduction of pasture and grazing schemes with five paddock systems as mentioned in the Ward Development Plan must be carried out as soon as possible, otherwise the degradation of the grazing area with severe surface erosion will expand.

(4) Woodlot

There is a shortage of firewood for the necessary daily cooking uses especially in the Choo and Nyachere Village. Inhabitants of those villages must buy their firewood from Mozambican or villagers far 2 or 3 km east, because the cutting of trees in the mountains adjacent to those villages is prohibited for conservation purposes.

It is suggested that the plantation of trees such as a gum tree, eucalyptus and so forth along the farm roads and drainage canals newly provided in the

irrigation scheme. The Planting and maintenance of these trees will be executed by women and children groups sharing certain plantation areas. When these trees have grown and will be available for branch cutting these groups will be able to sell these cut branches for firewood to the inhabitants.

(5) Garden/Orchards

The present existing trees such as mangos, paw paw and citrus are doing very well irrespective of very little management. These are planted on homesteads to provide shade as well as fruits.

The gardens/orchards in the area are not scheduled into irrigation scheme. Therefore fruit production will be limited to homesteads.

(6) Others

The traffic conditions in the project area will drastically be improved with the construction of the Regina Coeli Road, the Nyakomba - Nyangwayo Mazumbe Road, Bariri Road and farm roads. (Refer the chapter 3.2.3)

The inhabitants in the project area will also receive benefits from the irrigation scheme by using water for domestic use or for animal husbandry which can be easily procured from the irrigation canals or the night storage dams.

Social services such as communication lines, electrical power supply, sanitation to raise basic human needs shall be provided in the project area as mentioned in the Ward Development Plan.

4.3.3 Reallocation Plan

(1) Premise of the Reallocation Study

1) Premise

There are many variable factors on farming activities affecting to crop yield,

i.e., weather conditions (such as rainfall, drought, temperature, sunshine duration, frost, etc.), soil conditions, farmer's personal capabilities and skills, seed quality, occurrence of pests and/or disease, workability of tools and equipment in use and so forth.

The following premises will be given in the study for the reallocation of cultivated land.

Premise

i) Acreage of Net Cultivated Land

Present: 1,142ha of dryland farming

Project: 680ha of Irrigated farming, and 462ha of dryland farming

ii) Crops and their rotation

Present: Cotton (40%), Maize (55%) Sunflower (3.5%) and Tobacco(1.5%) single cropping

Project: Irrigation Area ;

Maize, Cotton, Tobacco, Groundnuts, Sugar beans, Wheat andonion, cropping rotation as shown in Fig 4.4.1.

Dryland Area ;

Maize (55%) and Cotton (45%), single cropping

iii) Households

618 households, which is the total number of households presently inhabiting the project area. This figure will be fixed for the reallocation plan.

iv) Population

3,559 persons, which is the total population of the project area. Out of it, 615 persons are male and 762 persons are female adults over the age of 15 years and these numbers will be used for the evaluation of the labour availability on farming.

v) Typical Farmer's size

The typical farmer, which was decided from the sampling surveys and interviews with representative farmers in the project area, is 7.56 persons per family and holds 1.89ha of net cultivated land. These figures are little bit higher than the average family size and average land holding of the villagers which are shown in Table 3.4.1 "Summary of Villages".

Table 4.3.2 shows the average typical farmer's family composition. This

table suggest that the typical farmer is composed of parents with 5 or 6 sons/daughters, of which one or two persons are adults over the age of 15 years who are working as farmers or other jobs or attending school, and four persons are usualy children below the age of 15 years.

Table 4.3.2 THE AVERAGE FAMILY COMPOSITION OF A TYPICAL FARMER

(Unit; persons)

description	Male	Female	Total
Farming	0.88	1.74	2.62
Non-Farming	-	-	0.94
Children below 15years	-	-	4.00
Total	-	-	7.56

source: Sampling surveys and interviews with representative farmers, JICA Team.

Note : Non Farming are workers other than farming or students

vi) Working hours per day in the fields.

6.0 hours per day is considered the actual working hours in the fields excluding 2.0 hours for the daily work preparations, commuting between the homestead and the work field, the clearing of products and tools and so forth or for the daily homemaking by the wife. During the peak season field work such as planting and harvesting, however, extends the working hours in the fields up to 8 hours.

Communal farmers have a difficult time employing labour from other areas due to the scale of their farming, financial situation and the productivity of their land. During the peak season the whole families shall be put to work.

vii) Family Labour Forces

100% of the adults over the age of 15 years will be counted as the available family labour force. 2.6 persons per day is the figure used

for the labour requirements of typical farmers.

viii) Utilization of draught Power

Present: Oxens are used for plough/harrowing cultivating and tranportation

Project: Irrigation Area ; Oxen and/or Tractor
Dryland Area ; Oxen only

(2) Labour and Draught Power Inputs for Each Crop

Labour and draught power input requirements for crop productions were estimated for each crop referring to the Farm Management Handbook, AGRITEX 1982, and the survey results from farmer interviews at the Nyamaropa Irrigation Scheme and the Nyakomba Ward.

Operation efficiency applies 65% of standard inputs for intensive farming considering practical conditions and the extent of farming in the project area.

Labour and draught power input requirements are summarized in the Table 4.3.3, and a breakdown of these are shown in Annex C-1 and C-2.

Table 4.3.3 LABOUR AND DRAUGHT REQUIREMENTS

Crop	Required Input per hectare	
	Labour	Oxen
	(days)	(days)
Irrigation Area		
Cotton	180.0	33.0
Maize	125.0	32.0
Tobacco	245.0	31.0
Sugar beans	92.0	24.0
Wheat	110.0	25.0
Onion	170.0	33.0
Ground nuts	110.0	23.0
Dryland Area		
Cotton	135.0	32.0
Maize/sunflower	105.0	28.0
Tobacco	210.0	33.0
Sugar beans	77.0	22.0

An Operational calendar for each crop to be used as a model for the estimation of annual labour and draught requirements are also shown in Annex C-3.

(3) Labour Requirements

Labour requirement for crop cultivating in the study area covering 1,142ha were calculated according to the following cases:

i) Present Conditions for dryland farming of the 1,142ha; the crops are 55% for maize, 3.5% for sunflower, 1.5% for tobacco and 40% for cotton.

ii) Project conditions for the irrigated farming of 680ha; crops are as in the cropping patterns table shown in Fig 4.4.1, and for the dryland farming of 462ha; the crops are 55% for maize and 45% for cotton.

The estimated labour requirements for the present and project are 135,400 and 270,000 Labour-days per year respectively, Table 4.3.4 and Table 4.3.5 show the results from seasonal labour requirement culculations for the present and the project.

Seasonnal peaks occure 2 or 3 times per year when during land preparation, planting and harvesting periods, Fig. 4.3.1 shows the seasonal labour requirement trends.

At present, the peak season come 3 times, during late-Oct to early-Nov, mid-Dec to early-Jan and mid-Mar to mid-May. The period with the maximum labour requirements is in late-Mar, around 10,100 larbour-days/10 days are needed.

This figure shows that 73% of the family labour force in total for the project area are spent for the harvesting of maize, cotton and sunflower. There may be an allowable margin in the labour force from the view point of the total labour requirements for the project area. Of course each farmer's work in his holding cultivation area have peaks which labour requirements may exceed the family labour force, and he therefore must borrow or hire certain amount of labour which can be covered with the co-working of neighbouring families.

In the project, the peak seasons will also come 3 times from mid-Oct to late-Oct, early-Mar to early-May and early-Sep to mid-Sep. There are maximum labour requirement periods on mid-Oct and late-Apr, around 15,370 labour-days/10 days and 13,100 labour-days/10 days respectively will be needed.

Fig. 4.3.1 CROPPING CALENDAR AND LABOUR INPUT

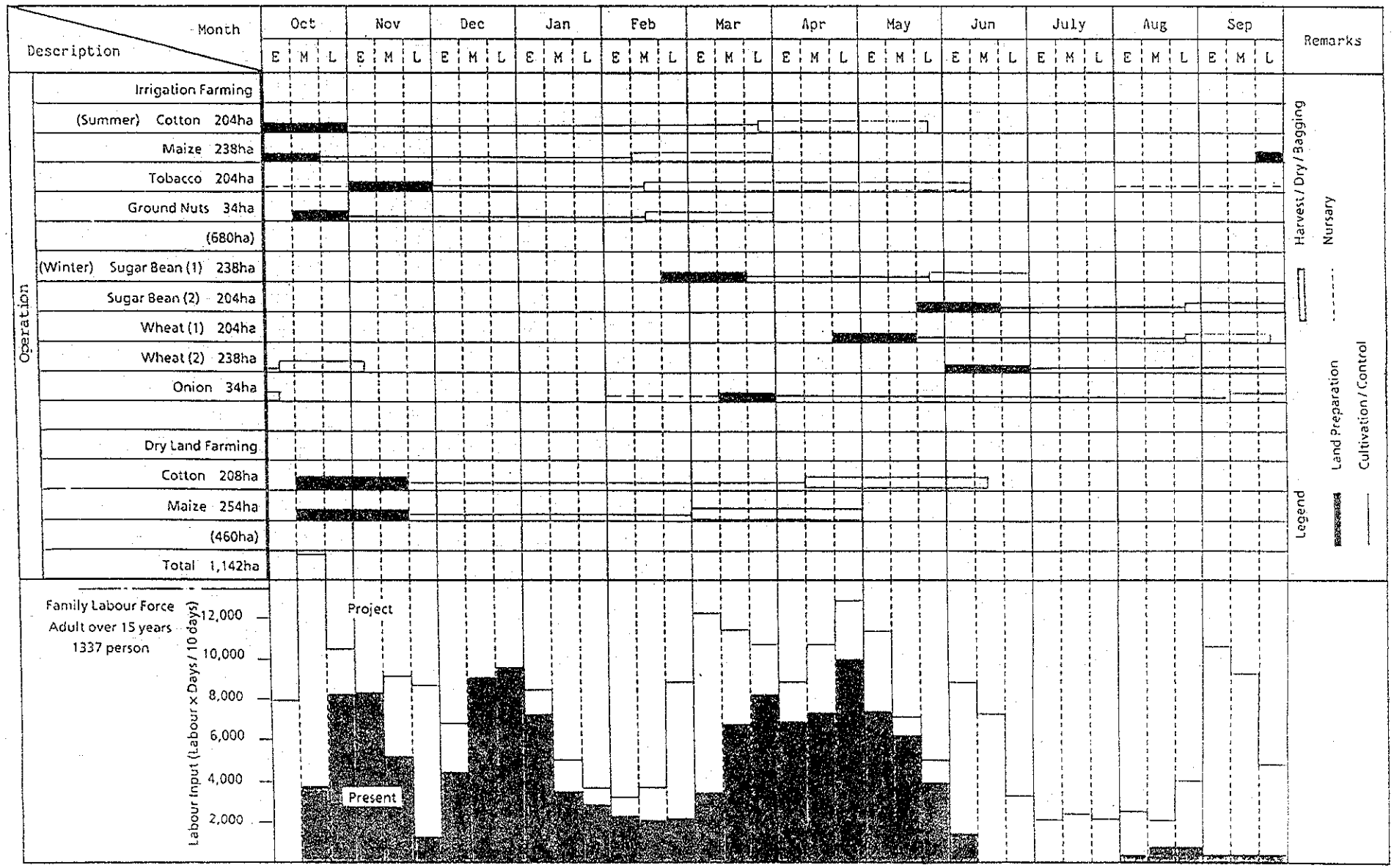


Table 4.3.4 LABOUR AND DRAUGHT POWER REQUIREMENT IN PRESENT CONDITION

Labour (Unit : labour-days/10days)

Crop	Cotton	Maize	Sunflower	Tabacoo	Total
Area (ha)	457	628	40	17	1142
	0.00	0.00	0.00	17.00	17.00
October	1635.52	2172.88	138.40	17.00	3863.80
	3221.85	4804.20	306.00	17.00	8349.05
	3244.70	4835.60	308.00	128.86	8517.16
November	1960.53	2838.56	180.80	336.26	5318.15
	776.90	251.20	16.00	229.50	1273.60
	959.70	3328.40	212.00	90.95	4591.05
December	1416.70	7159.20	456.00	182.75	9214.65
	1498.96	7536.00	480.00	247.35	9762.31
	2422.10	4471.36	284.80	232.90	7411.16
January	2742.00	678.24	43.20	105.57	3569.01
	2513.50	376.80	24.00	50.83	2965.13
	1946.82	376.80	24.00	33.49	2381.11
February	1645.20	345.40	22.00	37.23	2049.83
	1645.20	314.00	20.00	137.70	2116.90
	1645.20	1444.40	92.00	248.20	3429.80
March	1645.20	4710.00	300.00	248.20	6903.40
	1325.30	6594.00	420.00	205.70	8545.00
	1189.20	5294.04	337.20	170.00	6989.44
April	3093.89	4819.20	256.00	112.20	7481.29
	5301.20	4389.72	279.60	112.20	10082.72
	7586.20	0.00	0.00	96.90	7683.10
May	6580.80	0.00	0.00	79.90	6660.70
	4021.60	0.00	0.00	79.90	4101.50
	1572.08	0.00	0.00	76.33	1648.41
June	205.65	0.00	0.00	0.00	205.65
	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00
July	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	34.68	34.68
August	0.00	0.00	0.00	68.68	68.68
	0.00	0.00	0.00	68.68	68.68
	0.00	0.00	0.00	34.68	34.68
September	0.00	0.00	0.00	34.68	34.68
	0.00	0.00	0.00	34.68	34.68
Total	61695.00	65940.00	4200.00	3570.00	135405.00

Draught Power (Unit : head/10days)

Crop	Cotton	Maize	Sunflower	Tabacco	Total
Area (ha)	457	628	40	17	1142
	0.00	0.00	0.00	0.00	0.00
October	2892.81	3975.24	253.20	0.00	7121.25
	3199.00	4213.88	268.40	0.00	7681.28
	3221.85	4220.16	268.80	197.54	7908.35
November	297.05	200.96	12.80	232.22	743.03
	45.70	62.80	4.00	37.48	149.98
	68.55	94.20	6.00	2.55	171.30
December	91.40	439.60	28.00	2.55	561.55
	182.80	659.40	42.00	2.55	886.75
	434.15	628.00	40.00	2.55	1104.70
January	571.25	213.52	13.60	2.55	800.92
	571.25	62.80	4.00	2.55	640.60
	269.63	62.80	4.00	2.55	338.98
February	159.95	62.80	4.00	5.10	231.85
	159.95	62.80	4.00	11.90	238.65
	159.95	628.00	40.00	13.60	841.55
March	159.95	628.00	40.00	15.30	843.25
	137.10	628.00	40.00	11.90	817.00
	68.55	565.20	36.00	10.20	679.95
April	170.23	94.20	6.00	2.55	280.98
	365.60	81.64	5.20	2.55	454.99
	502.70	0.00	0.00	0.85	503.55
May	457.00	0.00	0.00	0.85	457.85
	274.20	0.00	0.00	0.85	275.05
	91.40	0.00	0.00	0.34	91.74
June	63.98	0.00	0.00	0.00	63.98
	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00
July	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00
August	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00
September	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00
Total	14624.00	17584.00	1120.00	561.00	33889.00

Table 4.3.5 LABOUR REQUIREMENT IN PROJECT CONDITION

Labour Requirement (Ward Total, Irrigation)

(Unit : labour-days/10days)

Crop	Cotton	Maize	Tabacoo	G.Nuts	S.Bean(1)	S.Bean(2)	Wheat(1)	Wheat(2)	Onion	Sub-Total(IR)	Cotton	Maize	Sub-Total(DRY)	Total
Area (ha)	204	238	204	34	238	204	204	238	34	680	208	254	462	1142
	1134.24	2898.84	204.00	0.00	0.00	0.00	0.00	3427.20	296.14	7960.42	0.00	0.00	0.00	7960.42
October	2321.52	1763.58	204.00	365.84	0.00	0.00	0.00	9139.20	0.00	13794.14	698.88	878.84	1577.72	15371.86
	1346.40	266.56	204.00	390.32	0.00	0.00	0.00	5783.40	0.00	7990.68	1466.40	1943.10	3409.50	11400.18
	359.04	316.54	1546.32	40.80	0.00	0.00	0.00	411.74	0.00	2674.44	1476.80	1955.80	3432.60	6107.04
November	601.80	2115.82	4035.12	41.14	0.00	0.00	0.00	0.00	0.00	6793.88	892.32	1148.08	2040.40	8834.28
	683.40	4550.56	2758.08	124.10	0.00	0.00	0.00	0.00	0.00	8116.14	353.60	101.60	455.20	8571.34
	973.08	3120.18	1264.80	154.70	0.00	0.00	0.00	0.00	0.00	5512.76	436.80	1346.20	1783.00	7295.76
December	1495.32	714.00	2437.80	215.90	0.00	0.00	0.00	0.00	0.00	4863.02	644.80	2895.60	3540.40	8403.42
	1856.40	347.48	3468.00	181.90	0.00	0.00	0.00	0.00	0.00	5853.78	682.24	3048.00	3730.24	9584.02
	1874.76	347.48	3315.00	154.70	0.00	0.00	0.00	0.00	0.00	5691.94	1102.48	1808.48	2910.88	8602.82
January	1383.12	349.86	1780.92	52.70	0.00	0.00	0.00	0.00	0.00	3566.60	1248.00	274.32	1522.32	5088.92
	1130.16	69.02	1181.16	23.80	0.00	0.00	0.00	0.00	0.00	2404.14	1144.00	152.40	1296.40	3700.54
	1130.16	69.02	928.20	23.80	0.00	0.00	0.00	0.00	71.40	2222.58	886.08	152.40	1038.48	3261.06
February	1130.16	916.30	628.32	6.80	0.00	0.00	0.00	0.00	142.80	2824.38	748.80	139.70	888.50	3712.88
	1130.16	2856.00	1986.96	490.28	1506.54	0.00	0.00	0.00	71.40	8041.34	748.80	127.00	875.80	8917.14
	1113.84	3113.04	3468.00	491.30	2744.14	0.00	0.00	0.00	37.40	10967.72	748.80	584.20	1333.00	12300.72
March	771.12	2265.76	3468.00	491.30	1601.74	0.00	0.00	0.00	399.84	8997.76	748.80	1905.00	2653.80	11651.56
	591.60	2265.76	2856.00	490.62	464.10	0.00	0.00	0.00	962.20	7630.28	603.20	2667.00	3270.20	10900.48
	2295.00	0.00	2374.56	0.00	1630.30	0.00	0.00	0.00	47.60	6347.46	540.80	2141.22	2682.02	9029.48
April	4153.44	0.00	1632.00	0.00	1892.10	0.00	0.00	0.00	205.70	7883.24	1408.16	1625.60	3033.76	10917.00
	4402.32	0.00	1632.00	0.00	1447.04	0.00	1240.32	0.00	249.90	8971.58	2412.80	1775.46	4188.26	13159.84
	3361.92	0.00	1469.80	0.00	1654.10	0.00	1530.08	0.00	249.90	8264.72	3452.80	0.00	3452.80	11717.52
May	1281.12	0.00	1264.80	0.00	892.50	0.00	556.92	0.00	235.70	4201.04	2995.20	0.00	2995.20	7196.24
	199.92	0.00	1264.80	0.00	168.98	1291.32	285.60	0.00	202.30	3412.92	1830.40	0.00	1830.40	5243.32
	0.00	0.00	1224.00	0.00	2737.00	2352.12	408.00	1447.04	202.30	8370.46	715.52	0.00	715.52	9085.98
June	0.00	0.00	0.00	0.00	3498.60	1372.92	571.20	1785.00	202.30	7430.02	93.60	0.00	93.60	7523.62
	0.00	0.00	0.00	0.00	1658.86	397.80	591.60	649.74	137.70	3435.70	0.00	0.00	0.00	3435.70
	0.00	0.00	0.00	0.00	0.00	1397.40	440.64	333.20	41.82	2213.06	0.00	0.00	0.00	2213.06
July	0.00	0.00	0.00	0.00	0.00	1621.80	285.60	476.00	28.90	2412.30	0.00	0.00	0.00	2412.30
	0.00	0.00	0.00	0.00	0.00	1240.32	285.60	666.40	30.60	2222.92	0.00	0.00	0.00	2222.92
	0.00	0.00	428.40	0.00	0.00	1417.80	81.60	690.20	30.60	2648.60	0.00	0.00	0.00	2648.60
August	0.00	0.00	836.40	0.00	0.00	765.00	81.60	514.08	28.90	2225.98	0.00	0.00	0.00	2225.98
	0.00	0.00	836.40	0.00	0.00	144.84	2937.60	333.20	23.80	4275.84	0.00	0.00	0.00	4275.84
	0.00	0.00	428.40	0.00	0.00	2346.00	7833.60	333.20	6.80	10948.00	0.00	0.00	0.00	10949.00
September	0.00	0.00	428.40	0.00	0.00	2998.80	4957.20	95.20	804.10	9283.70	0.00	0.00	0.00	9283.70
	0.00	1404.20	426.36	0.00	0.00	1421.88	352.92	95.20	1099.90	4800.46	0.00	0.00	0.00	4800.46
Total	36720.00	29750.00	49980.00	3740.00	21896.00	18768.00	22440.00	26180.00	5780.00	215254.00	28080.00	26670.00	54750.00	270004.00

These figures show the shortages in the labour force two times a year. If possible, these shortage will be alleviated with good cooperation between the farmers.

In mid-Oct, the harvesting of wheat and the ploughing/planting of cotton and maize overlap. 30% of the children between the ages of 10 to 15 can be used for the work, women's work in the field can be saved by around 75%. And in late-Apr, the picking of cotton and the harvesting of tobacco and maize will also require the childrens' assistance.

It is known that the project's conditions will keep the farmer busy with the farming practices during the year to be able to reap the benefit from the irrigation scheme. The co-working/co-cultivation organizing of the farmer's groups under the guidance of AGRITEX in the irrigation scheme and the assistance of children over of the age of 10 years in the peak seasons are needed to construct good communal farming in this area.

(4) Draught Power Requirements

Draught power requirements are also calculated in the same way as labour requiements. The Annual requirement is estimated at 900 and 58,000 head-days at present and for projected conditions respectively. Table 4.3.4 and Table 4.3.6 show the results of seasonal draught power requirement calculations for the present and the project's conditions.

At present, the peak seasons come in October and November with about 790 oxen per day required, the present oxen holdings in the project area are 460 head. Around 80% of them would be the number in constant working availability. These figures show the severe shortage of present draught power. Dryland farming strongly depends on the timing of the first rain, if the first rain comes early, ploughing can take a long time. But if the delay is too long, the available time for planting will be delayed and short due to the concentrated draught power requirements, and will cause a low yielding crop. Bulls and cows even heifers will be used for ploughing when there is an oxen shortage.

Once the irrigation scheme starts, annual draught power requirements will increase to about 17% of the present requirements, and the peak periods will appear from October to early November for the ploughing and planting of cotton,

Table 4.3.6 DRAUGHT POWER IN PROJECT CONDITION

Draught Power (Ward Total, Irrigation)

(Unit : head/10days)

Crop	Cotton	Maize	Tabacco	G.Nuts	S.Bean(1)	S.Bean(2)	Wheat(1)	Wheat(2)	Onion	Sub-Total(IR)	Cotton	Maize	Sub-Total(DRY)	Total
Area (ha)	204	238	204	34	238	204	204	238	34	680	208	254	462	1142
October	1950.24	2403.80	0.00	0.00	0.00	0.00	0.00	166.60	2.04	4522.68	0.00	0.00	0.00	4522.68
	2146.08	130.90	0.00	650.42	0.00	0.02	0.00	416.50	0.00	3343.90	1316.64	1607.82	2924.46	6268.36
	193.80	16.66	0.00	5.10	0.00	0.00	0.00	273.70	0.00	489.26	1456.00	1704.34	3160.34	3649.60
November	20.40	26.18	2370.48	3.40	0.00	0.00	0.00	38.08	0.00	2458.54	1466.40	1706.88	3173.28	5631.82
	20.40	342.72	2786.64	3.40	0.00	0.00	0.00	0.00	0.00	3153.16	135.20	81.28	216.48	3369.64
	20.40	649.74	438.60	2.38	0.00	0.00	0.00	0.00	0.00	1111.12	20.80	25.40	46.20	1157.32
December	20.40	342.72	20.40	0.00	0.00	0.00	0.00	0.00	0.00	383.52	31.20	38.10	69.30	452.82
	42.84	28.56	20.40	0.00	0.00	0.00	0.00	0.00	0.00	91.80	41.60	177.80	219.40	311.20
	261.12	19.04	20.40	0.00	0.00	0.00	0.00	0.00	0.00	300.56	83.20	266.70	349.90	650.46
January	446.76	19.04	20.40	0.00	0.00	0.00	0.00	0.00	0.00	786.76	197.60	254.00	451.60	1238.36
	322.32	19.04	20.40	0.00	0.00	0.00	0.00	0.00	0.00	361.76	260.00	86.36	346.36	708.12
	132.60	19.04	20.40	0.00	0.00	0.00	0.00	0.00	0.06	172.04	260.00	25.40	285.40	457.44
February	34.68	19.04	20.40	0.00	0.00	0.00	0.00	0.00	3.40	77.52	122.72	25.40	148.12	225.64
	20.40	316.54	40.80	0.00	0.00	0.00	0.00	0.00	3.40	381.14	72.80	25.40	98.20	479.34
	20.40	614.04	102.00	102.00	2277.66	0.00	0.00	0.00	3.40	3119.50	72.80	25.40	98.20	3217.70
March	20.40	316.54	102.00	5.10	2387.14	0.00	0.00	0.00	3.40	2834.58	72.80	254.00	326.80	3161.38
	20.40	19.04	102.00	5.10	114.24	0.00	0.00	0.00	653.82	914.60	72.80	254.00	326.80	1241.40
	48.96	19.04	102.00	5.10	23.80	0.00	0.00	0.00	68.34	267.24	30.00	254.00	284.00	551.24
April	142.80	0.00	61.20	0.00	23.80	0.00	0.00	0.00	3.40	231.20	31.20	228.60	259.80	491.00
	169.32	0.00	0.00	0.00	23.80	0.00	0.00	0.00	3.40	196.52	81.12	38.10	119.22	315.74
	169.32	0.00	20.40	0.00	23.80	0.00	1972.68	0.00	3.40	2189.60	166.40	33.02	199.42	2389.02
May	169.32	0.00	20.40	0.00	23.80	0.00	2093.04	0.00	3.40	2309.96	228.80	0.00	228.80	2538.76
	169.32	0.00	20.40	0.00	23.80	0.00	144.84	0.00	3.40	361.76	208.00	0.00	208.00	569.76
	169.32	0.00	14.28	0.00	23.80	1952.28	20.40	0.00	3.40	2183.48	124.80	0.00	124.80	2308.28
June	0.00	0.00	0.00	0.00	357.00	2046.12	20.40	2301.46	3.40	4728.38	41.60	0.00	41.60	4769.98
	0.00	0.00	0.00	0.00	357.00	97.92	20.40	2441.88	3.40	2920.60	29.12	0.00	29.12	2949.72
	0.00	0.00	0.00	0.00	52.36	20.40	20.40	168.98	3.40	265.54	0.00	0.00	0.00	265.54
July	0.00	0.00	0.00	0.00	0.00	20.40	20.40	23.80	3.40	68.00	0.00	0.00	0.00	68.00
	0.00	0.00	0.00	0.00	0.00	20.40	20.40	23.80	3.40	68.00	0.00	0.00	0.00	68.00
	0.00	0.00	0.00	0.00	0.00	20.40	0.00	23.80	0.00	44.20	0.00	0.00	0.00	44.20
August	0.00	0.00	0.00	0.00	0.00	20.40	0.00	23.80	0.00	44.20	0.00	0.00	0.00	44.20
	0.00	0.00	0.00	0.00	0.00	20.40	0.00	23.80	0.00	44.20	0.00	0.00	0.00	44.20
	0.00	0.00	0.00	0.00	0.00	20.40	142.80	23.80	0.00	187.00	0.00	0.00	0.00	187.00
September	0.00	0.00	0.00	0.00	0.00	306.00	357.00	0.00	0.00	663.00	0.00	0.00	0.00	663.00
	0.00	0.00	0.00	0.00	0.00	306.00	234.60	0.00	173.40	714.00	0.00	0.00	0.00	714.00
	0.00	2294.32	0.00	0.00	0.00	44.88	32.64	0.00	173.40	2545.24	0.00	0.00	0.00	2545.24
Total	6732.00	7616.00	6324.00	782.00	5712.00	4896.00	5100.00	5950.00	1122.00	44234.00	6623.60	7112.00	13735.60	57969.60

maize and tobacco and in June to plant sugar beans and wheat. The highest draught power requirements will occur in mid-Oct needing 630 head. It means that draught power shortages will be unavoidable at that time.

(5) Necessity to Introduce Tractors

As mentioned above (4), draught power will be severely short in the project's conditions. There are two ways to alleviate this shortage, one is to increase the number of cattle, the other is to introduce tractors with the necessary attachments.

It is not recommendable to increase the cattle numbers in the area due to the present overgrazing conditions as explained in chapter (6) of 3.4.1 and (3) of 4.3.2, preferably their numbers should decrease.

Therefore, the draught power shortage should be alleviated with the introduction of a certain number of tractors. The necessary number of tractors with 60 ps power is estimated at 15 tractors which include 3 auxiliary tractors.

- Shortage; 630 head − 460×80% ≒ 260 head

- Ploughing capacity of 260 oxen; 4 ox ploughing in 0.24 ha/day workability, 260/4 ×0.24= 15.6 ha/day.

- Necessary number of tractor;
  working capacity of one tractor for ploughing is 1.38 ha/day,
  15.6 ÷ 1.38 ≒ 12numbers, 12+3 (anxiliary) =15 numbers in total.

(6) Farming Scale

1) Available Family Labour Force

The relationship of peak labour requirements and the size of cultivated land holdings by on household is shown in Fig.4.3.2 in which one farmer cultivates only in the irrigated area and another only on dryland. The peak season for the required maximum labour force in irrigated farming area occures in mid-October for land preparations such as ploughing, disking and planting, the peak season for the dryland farming area occures in late-April for the cultivation of cotton and tobacco.

This relationship is linear, because of the same cropping rotaions and

equal crop shares were applied to every houshold as a farming premise to create effective irrigation management and the organized operation of the cropping systems, details of farming/cropping systems and irrigation practices will be set forth in the following chapters in the agricultural development plan and the irrigation plan.

The cropping intensity in the Nyamaropa Irrigation Scheme is staying at a low level being 1.7 on irrigated land. There is a high water loss in irrigation due to the difficulty of on-time and effective irrigation according to the schedule provided by the Irrigation Office, Nyamaropa. This difficulty was caused by free cropping in any plot depending on the convenience and choice of the farmer.

In the irrigation area of this project, such failures will not be accepted as to draw the highest target of agricultural production and the improvement of the farmers' life. AGRITEX request the study team to make a good plan for the maximum utilization of important water with that highest forcast. Cultivation methods of one crop in one block commanded by one branch irrigation canal at one season is planned the results were taken from various studies from the present and projected conditions in the project area. This method will give a rational and the most effective operation of the irrigation system, but will also provide the possibility for co-operation crop cultivation. The land allocated in the irrigated area to one household will be divided into four plots, namely 3 plots with 30% holding shares and one plot with 10% shares, to meet the above requirements.

The marginal size of net cultivated land allocated on the irrigated farming area or dryland farming area are estimated as 1.0ha or 2.3ha respectively, for which the holding by a small scale household composed of two adults and children less than 10 years old. And it's size for the typical farmer composed of 3 ~4 family labour force members, who have 2.62 persons tending to farm on average, will be of 1.3ha or 2.8ha respectively.

To operate and manage the above mentioned marginal size of land, the required labour forces for the busy farming season from August to November are calculated for model farmers cultivating 1.0ha and/or 1.5ha of irrigated area. Results of these calculations are shown in Fig.4.3.3.(1.0ha) and Fig.4.3.4(1.5ha).

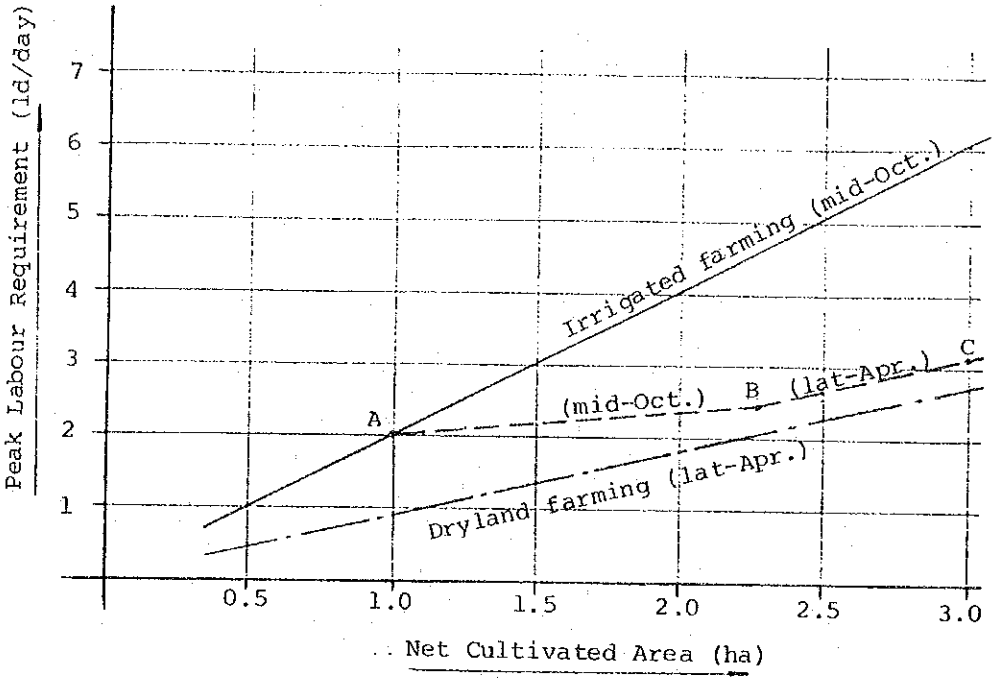


Fig. 4. 3. 2 PEAK LABOUR REQUIREMENT

The required labor force for 1.0ha of irrigated area can be carried out by two family labour force members although they are busy in harvesting wheat. In consideration with necessary working hours for housework, preparation work for farming, attention to livestock, transport of agricultural products and so forth, the 1.0 ha size will be the margin for cultivation by small scale households. For the 1.5ha, it is necessary for it to be attended continuously by two family labour force members for more than 2 months without a rest or idle time, and there will be the need for one more labour force members for the harvesting of wheat. The 1.5ha of Land will be allocated to the large scale household keeping more than four family Labour force members considering rest days and other required work.

The dotted line A-B-C on Fig.4.3.2 shows the peak labour requirements where reallocation for the households has been carried out in consideration with combined cultivation based on 1.0ha of irrigated farming plus additional dryland farming. According to this line, a household keeping three labour force members can cultivate up to 2.85ha of such a combined area. But as explained above, a farmer needs time for other work and rest. Therefore, the applicable farming scale for maximum reallocation size for the largest scale household shall be made at around 2.40ha which is equivalent to 85% of that.

Irrigated areas with 1.0ha sizes considering in the above are the same as marginal size are applicable for the small scale household.

2) Economic Balance for Each Farming Scale

To study the economic balance depends on the farming scale, therefore model households with various farming scales were set up. The agricultural net income was estimated for each model household, a household's subsistence is determined by the net income of agricultural and non-farming incomes. Agricultural net income is born by the surplus between the selling of agriculture products such as crops and livestock and agricultural inputs such as the cost for seeds, fertilizer and chemicals and labour hiring cost.

Table 4.3.7 shows A) holding cultivated land, B) Family composition, C) Agricultural gross income, D) Agricultural input cost, E) Irrigation change on project conditions, F) Agricultural net income, for each model household.

Fig. 4.3.3 LABOUR REQUIREMENT OF MODEL FARMING FOR 1.0 ha OF IRRIGATED LAND

Description \ Month	Required ld.	Aug L	Sep E	Sep M	Sep L	Oct E	Oct M	Oct L	Nov E	Nov M	Nov L	Remarks
1. Cotton : 0.30ha												
Plough / Disking	1.43×2											
Row / Fertilizer / Planting	1.38×2											
Herbicide	0.62×1											
2. Maize : 0.35ha												
Plough / Disking	1.43×2 / 0.24×2											
Row / Fertilizer / Planting	1.58×2 / 0.64×1											
Herbicide	0.62×1 / 0.10×1											
3. Tobacco : 0.30ha												
Plough / Disking	1.43×2											
Fertilizer / Ridging	0.27×2 / 1.23×1											
Soil Fumigation	0.97×1											
Transplanting	3.15×2											
4. Sugar Bean (2) : 0.30ha												
Harvesting	2.28×2 / 2.54×2											
5. Wheat (1) : 0.30ha												
Harvesting (Reap / Thrust)	8.23×2											
Harvesting (Winnow / Bag)	3.37×2											
6. Wheat (2) : 0.35ha												
Harvesting (Reap / Thrust)	9.60×2											
Harvesting (Winnow / Bag)	3.93×2											
7. Onion : 0.05ha												
Harvesting (Lift / Windrow)	0.74×2 / 0.17×1											
Harvesting (Grade / Pocket)	0.78×2											
8. Ground Nuts : 0.05ha												
Plough / Disking	0.24×2											
Fertilizer / Ridging	0.26×2											
Weed Control	0.34×1											
Daily Labour Requirement												

Legend
1man
2men

Fig. 4.3.4 LABOUR REQUIREMENT OF MODEL FARMING FOR 1.5 ha OF IRRIGATED LAND

Description \ Month	Required ld.	Aug	Sep			Oct			Nov			Remarks
		L	E	M	L	E	M	L	E	M	L	
1. Cotton : 0.45ha												
Plough / Disking	1.43×2											
Row / Fertilizer / Planting	1.38×2											
Herbicide	0.62×1											
2. Maize : 0.525ha												
Plough / Disking	1.43×2 / 0.24×2											
Row / Fertilizer / Planting	1.58×2 / 0.64×1											
Herbicide	0.62×1 / 0.10×1											
3. Tobacco : 0.45ha												
Plough / Disking	1.43×2											
Fertilizer / Ridging	0.27×2 / 1.23×1											
Soil Fumigation	0.97×1											
Transplanting	3.15×2											
4. Sugar Bean (2) :0.45ha												
Harvesting	2.28×2 / 2.54×2											
5. Wheat (1) : 0.45ha												
Harvesting (Reap / Thrust)	8.23×2											
Harvesting (Winnow /Bag)	3.37×2											
6. Wheat (2) : 0.525ha												
Harvesting (Reap / Thrust)	9.60×2											
Harvesting (Winnow /Bag)	3.93×2											
7. Onion : 0.075ha												
Harvesting (Lift / Windrow)	0.74×2 / 0.17×1											
Harvesting (Grade / Pocket)	0.78×2											
8. Ground Nuts : 0.075ha												
Plough / Disking	0.24×2											
Fertilizer / Ridging	0.26×2											
Weed Control	0.34×1											
Daily Labour Requirement												

Legend
1man
2men
3men

Table 4.3.7 ECONOMIC BALANCE OF MODEL HOUSEHOLDS

	Present Condition					Project Condition							
	Dry Land Farming					Irrigated Farming Only				Irrigated + Dry Land Farming			
Dry Land	0.5	1.0	1.5	2.0	3.0	-	-	-	-	0.5	0.75	1.0	1.5
Irrigation Land	-	-	-	-	-	0.5	1.0	1.5	2.0	1.0	1.0	1.0	1.0
A) Total Area (ha)	0.5	1.0	1.5	2.0	3.0	0.5	1.0	1.5	2.0	1.5	1.75	2.0	2.5
Adult over 15	2	2	3	4	5	2	2	4	5	3	3	4	5
Children 15	1	2	3	4	5	1	2	4	5	3	4	4	5
B) Family (persons)	3	4	6	8	10	3	4	8	10	6	7	8	10
Crop Sales	285	672	1,006	1,425	2,228	3,099	6,348	9,369	12,552	6,721	6,930	7,113	7,495
Livestock Sales	17	34	51	68	101	17	34	51	68	51	64	68	85
C) Gross Income (Z$)	302	706	1,057	1,493	2,329	3,116	6,382	9,620	12,620	6,772	6,994	7,181	7,580
Agricultural Input	218	436	654	872	1,308	844	1,688	2,532	3,376	1,906	2,031	2,124	2,342
Hired Labour	-	-	38	50	76	-	-	39	52	38	48	51	64
D) Input Cost (Z$)	218	436	692	922	1,384	844	1,688	2,571	3,428	1,944	2,079	2,175	2,406
E) Irrigation Charge	-	-	-	-	-	225	450	675	900	450	450	450	450
F) Net Income (Z$) C) - D) - E) = F)	84	270	365	571	945	2,047	4,244	6,374	8,292	4,378	4,465	4,556	4,724

The study was carried out on 3 conditions such as the present condition on dryland farming, project conditions on irrigated farming, and the project conditions on 1.0ha of irrigated farming plus some dryland farming.

In Table 4.3.7, it is clear that the present households within the farming scales receive a low income from farming and depend on non-farming incomes such as remittance or assistance from outside. Households may be able to balance their income and expenditures for their required subsistence by saving on input materials such as fertilizers and chemicals or by minimizing family subsistence. The out-migration of about 400 people to work might prove this fact.

Communal land farming should basically be a self sustained unit and should not expect to receive any assistance or remittances from outside in order to satisfy its subsistence requirements in compliance with the policy of the Government. The establishment of an irrigation scheme should ensure this policy.

The reallocation plan for the irrigated farming area including considerations for the dryland farming area should be provided on the basis of fairness and growth with equity and to ensure minimum subsistence household requirements.

The determining of minimum subsistence requirements is quite difficult, because these requirements will be decided by communal land development strategies in the country, provincial and regional level and by the farmers' requirement for their life level.

In this report, as to acquire the material necessary to proceed in the study, the amount of 4,100 Z$ is suggested as the target minimum net income level to be ensured for the households. Out of it, 3,570 Z$ as a target minimum subsistence requirement is carried out from the average annual expenditure of small scale farmer, which was surveyed at 1984 to 1985 for a sampled 7,000 residents national-wide by the Central Statistical Office. The 2,533 Z$ is that average annual expenditure in 1985 and conversion factor 1.41 is the consumer price index between 1985 and 1990, these figures was multiplied to make the figure of 3,570 Z$. Another 530 Z$ is added to 3,570 Z$ as a surplus disposable income.

The farming scale to ensure an income more than such target minimum net

income is in the unit of a larger than 1.0 ha of irrigated land or the combination of 1.0 ha of irrigated land and more than 0.5 ha of dryland.

(7) Reallocation Plan

According to the above studies in (6) from the view points of required labour forces and the economic balance of households, the following reallocation plan is suggested for the project. But, the decision of plot sizes to be reallocated to the householders and its method will depend on Govenmental policy, these suggestions, therefore, shall be considered for references.

Reallocation Plan

(i) For small scale Household ..... 1.0ha of irrigated land only

(ii) For Typical Farmer's class ..... 1.0ha of irrigated land plus around 0.75ha of dryland farming area.

(iii) For large scale Household ..... (1) 1.0ha of irrigated land plus some dryland farming *) area

or (2) 1.5ha of irrigated land only

The size of the dryland farming area to be reallocated for the large scale household will be decided in accordance with the capacity of each family's labour force.

The present land holding situation in the project area varies. There is probably an inbalance between family sizes and the holding of cultivated areas for each household, because the communal land took around 40 years since the inicial settlement in 1950's commenced. The farmer may also think that their holding lands are their private land, even though this land is communal land and its owner ship depends on the President and the farmer if he is allowed to hold the land for the purpose of agriculture and residence in compliance with the Communal Land Act.

With these circumstances in mind, the following actions are recommended to be taken prior to the execution of reallocation to avoid confusion and complications during reallocation.

(i) The cadastral survey by mapping to make sure of the land holder on each lot of land. The Provision of lists showing the relationship be tween land and the household.

(ii) The evaluation of cultivated land in each lot for its productivity in consideration with an accessability, fertility, slope and so forth.

(iii) The evaluation of family labour forces available to attend the farming in each household.

After reallocation, there is the possibility of a cetain amount of land remaining. In this case, it is recommended that cultivated land located on steep mountain slopes and on river sides be divided from the land to be reallocated then be shifted to veld/pastures or woodlots for livestock breeding, conservation purposes and/or firewood production. If further land remaines, then settlement from outside of the project area will be considered in the same manner as for the households.

4.4 Agricultural Development Plan

4.4.1 Proposed Cropping System

(1) Introduction of Crops for the Proposed Cropping System

In the study area, double or triple cropping systems per year will be introduced if irrigation water is made available. Therefore, after the construction of irrigation facilities, the cropping intensity will increase in the area.

Among the principal crops, wheat and sugar beans can be introduced as winter crops. Maize, cotton, tobacco(air-curred) and sugar beans are suitable for present summer crops.

The characteristics of these crops are as follows:

1) Maize and wheat are staple foods for the people and have a long storage life. Their prices are controlled by the government. It should be noted that the production of these cereals will secure a sufficient amount for national consumption at any time.

2) Cotton is a cash crop for export and the price is controlled by the government. But a large labour force is required for harvesting.

3) Sugar beans are a cash crop with a high protein content and their prices are controlled by the government. Short growing periods and a low labour requirement are the advantage of these crops.

4) Tobacco(air-cured) is a cash crop for export and the price is not controlled by the government. For a higher output, intensive management is required during the cropping season.

On the other hand, vegetable production is important for rural and urban consumption. The study area is conparatively far from the city market, hence the production of transportable crops such as onions, cabbages and groundnuts are desirable. In the future, when transportation and market conditions improve, it will be possible to grow other horticultural products. Once the supply of electricity is improved, the establishment of cottage industries such as juicing or canning will be possible subject to the amount of horticultural

products and the financial support for these industries.

(2) Proposed Cropping System

It is important to maintain the soil's fertility and to avoid the deterioration of crop growth due to continuous cropping. After investigations and discussions with AGRITEX officials about these issues the following two cropping systems are proposed.

1) Cropping system Type I: Seven principal crops with a three year rotation is proposed. The adaptable area for this system occupies 90% of the irrigated land. This area is equally divided into three zones, a, b and c, which occupy 30% of the land each. In these zones, the same cropping system will be practiced but each zone starts with a different crop.

2) Cropping system Type II: Five crops consisting of a vegetable and cereals with a two year rotation is proposed. The adaptable area occupies 10% of the irrigated land which is further divided into two zones, d and e (5% of the land each). In these zones, cropping systems are the same but starting with different crops similarly as for Type I. In the future, some crops from these cropping systems might be replaced with other crops which are more suited to the marketing conditions of that time.

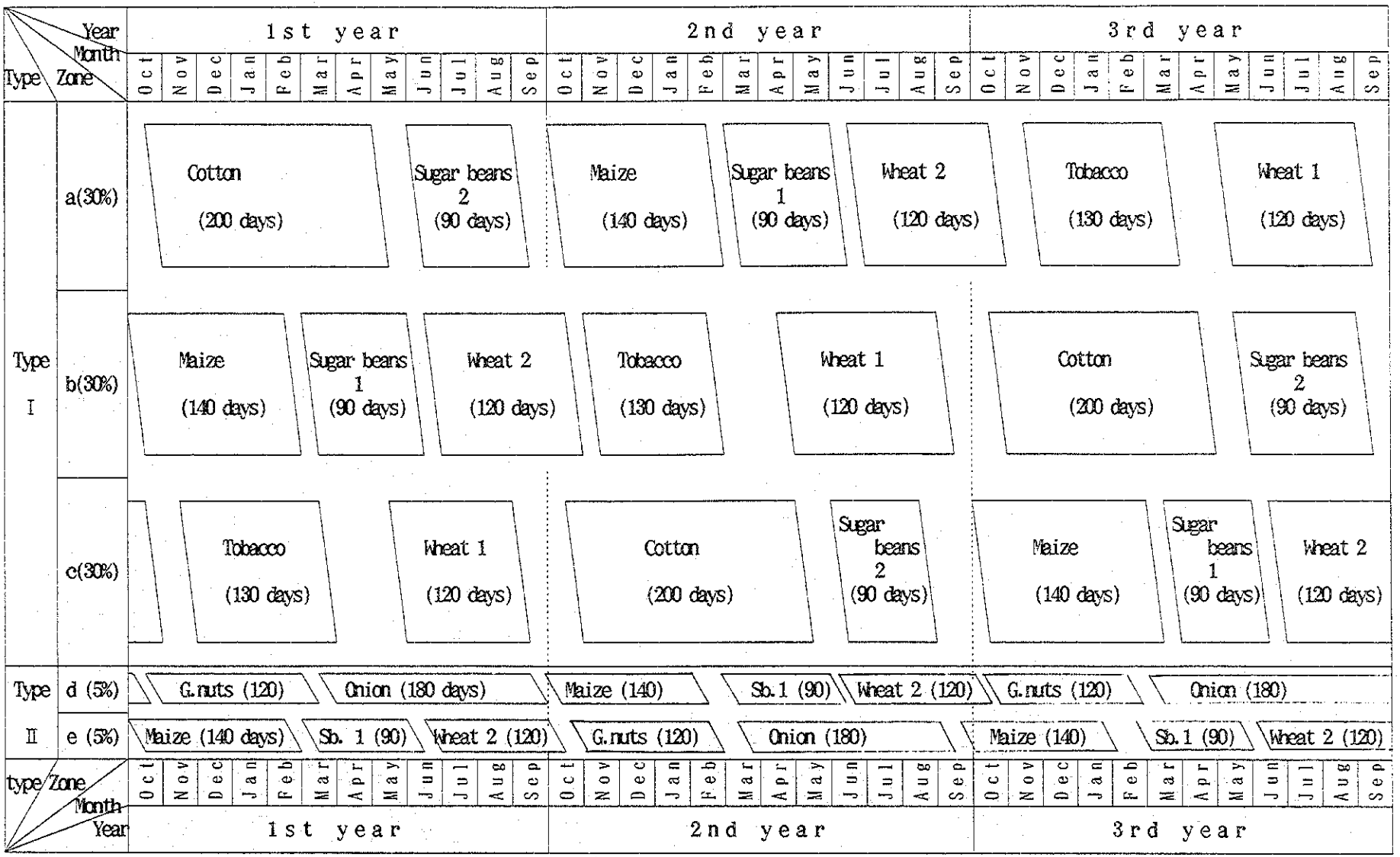
These proposed cropping systems under irrigated conditions are shown in Figure 4.4.1.

After the construction of the proposed irrigation facilities in the study area, most of the crops in cropping system Type I, such as maize, wheat, sugar beans and cotton can easily be grown in the area because the farmers already have experience with the management of these crops.

At present, tobacco(air-cured) was grown only on 14.9 hectares of the study area(see Table 3.4.4). It is difficult to grow it on large areas immediately after construction, because farmers planting tobacco require some intensive technical knowledge as well as tobacco barns for curing.

Accordingly, planting tobacco for first year will be concentrated on 5% of the irrigated land, which is approximately two times the area of planted tobacco at present. In the next year, tobacco planting will increase up to 10%

Fig. 4.4.1 PROPOSED CROPPING SYSTEM



Note: 1) G.nuts = groundnuts, and 2) Sb. = Sugar beans.

of the irrigated land through the efforts of farmers backed with technical and financial support of concerned agencies. Therefore, the area planted with tobacco will increase yearly step by step and reach the target area (30% of the irrigated land) five years after construction.

4.4.2 Proposed Farming Practices

Farming practices under irrigated conditions in the study area are cited from the 'Farm Management Handbook, Part 1 and 2' (AGRITEX, 1982) as well as being discussed with the AGRITEX staff members. As a result, suitable farming practices for eight crops were worked out and tabulated into Tables 4.4.1 (1) to 4.4.1 (4).

4.4.3 Yield and Production

The target yields per hectare anticipated for the Project area were obtained by taking into account the present crop production conditions at the farmers' level as well as the irrigation effects and yields obtained from the Nyamarspa Irrigation Scheme, etc. The total target yield per crop is estimated based on the unit target yield and the proposed cultivation area which is calculated at 204 ha (30% of the total area of 680 ha) for the crops in type I and 34 ha (5% of the total area) for the crops in type II.

The present and target yields are shown in Table 4.4.2.

4.4.4 Marketing and Price Prospects

The principal crops produced by farmers are to be sold to government authorities such as; the Grain Marketing Board(GMB) which deals with maize, wheat, sugar beans, groundnuts and some other grains, and the Cotton Marketing Board(CMB) which deals with cotton. The price for the above mentioned crops are controlled by the government; therefore, these crops may help stabilize the farming income of communal farmers.

The tobacco leaves are only to be sold to the Tobacco Marketing Board (TMB),