experiment station, there is a national experimental station of cotton near Kadoma and demonstration farm related to the cultivation of cotton is established next to the experimental station. With regard to other farm produce, there is no similar facility.

There is no facility that can predict the growth of pests. Under the current situation, even the extermination of army worms to cotton starts only after some damages have occurred.

Construction of large-scale water supply facility must wait for the realization of Kudu Dam to be constructed at Munyati river. However, for a while, securing of water source including deep wells, should be conducted by each village in order to support the vegetable cultivation for supplementing the nutrition.

Although it is considered rather difficult due to the scattered village system, effort to improve existing rural road network should be continued through pavement with gravel.

In the Study Area where the meteorological conditions are extremely sensible, research and experiment on farming technology of various type of crops as well as on pests control and spraying method, are inevitable.

3.10.2 Social Infrastructure

The present situation of social infrastructure is explained in Section 3.8 (8) in detail, among which roads and traffic must be adjusted with the infrastructure for agricultural production. The arrangement of cargo collection and storage facility and the location of business centres must also be taken into consideration.

Expansion of educational facilities in the rural areas is necessary in order to relieve the centralization of population to urban areas. Not only the secondary education such as the secondary and high schools, but special educational facilities mainly of agricultural education must be expanded.

Medical and health facilities are the least developed social

infrastructure. Considering the fact that the number of doctors and nurses is extremely small and the cases of malaria or epidemic diseases are large in number, significant expansion must be implemented.

Other infrastructure is considered to be implemented one by one using the size of local economy as a barometer.

3.11 Present Environmental Conditions

In 1994, the Ministry of Environment and Tourism (MET) published guidelines for Environmental Impact Assessment (EIA) for application to development projects likely to have significant environmental consequences (See APPENDIX J). According to the new policy, the purpose of EIA "is to ensure that the environmental and socio-economic costs and benefits of economic development projects are properly accounted for, that unwarranted negative impacts are avoided or mitigated, and that potential benefits are realized".

The list of prescribed activities under the new policy for which EIA reports are now required before implementation of new activities or substantial expansions to existing ones include the construction of dams and man-made lakes, irrigation schemes, and land development for agricultural production.

The present environmental concerns in the Study Area are:

(a) Population and resettlement
- displacement and relocation, compensation
- cultural and historical sites

(b) Environmental health issues
- water-borne and water-related diseases
- use of agrochemicals
- domestic water supplies and health
- sexually transmitted diseases

(c) Woody vegetation clearance
(d) Monitoring of mining activities

(e) Deterioration of soil condition

The above environmental concerns are detailed in Chapter 7 of this report.

Table 3-1 Demography of Study Area

NAME OF DISTRICT	CODE NUMBER AND NAME OF WARD		TYPE OF LAND	AREA	NUMBER OF HOUSEHOLDS	POPULATION
	NO.	NAME		㎢		
GOKWE NORTH	11	MAKORE1	COMMUNAL	168	1431	9159
	12	MAKORE2	COMMUNAL	141	1027	6148
	22	NYARUNGWE	RESETTLEMENT	130	172	1039
	24	COPPER QUEEN III	SMALL SCALE	297	300	2460
	25	COPPER QUEEN II	SMALL SCALE	277	329	2402
	26	COPPER QUEEN I	SMALL SCALE	239	238	1654
SUBTOTAL				1252	3497	22862
GOKWE SOUTH	23	CHISINA I	COMMUNAL	510	2336	14380
	24	CHISINA II	COMMUNAL	601	1807	11155
SUBTOTAL				1111	4143	25535
KWEKWE	6	MABURA	COMMUNAL	169	944	5542
	7	SIDAKENI	COMMUNAL	143	1106	5529
SUBTOTAL				312	2050	11071
KADOMA	15	SURISURI	LARGR SCALE	410	1510	6091
	17	MUZVEZVE I	RESETTLEMENT	924	1437	9681
	20	SANYATI COMMUNAL 20	COMMUNAL		517	2872
	21	SANYATI COMMUNAL 21	COMMUNAL		408	2368
	22	SANYATI COMMUNAL 22	COMMUNAL		673	3916
	23	SANYATI COMMUNAL 23	COMMUNAL	691	1078	6774
	24	SANYATI COMMUNAL 24	COMMUNAL		1115	6823
	25	CHENJIRI SMALL SCALE	SMALL SCALE		124	948
	26	CHENJIRI CENTRAL	SMALL SCALE		246	1564
	28	SACHURU	RESETTLEMENT	352	815	4763
SUBTOTAL				2377	7923	45800
TOTAL				5052	17613	105268

Table 3-2 CHARACTERISTICS OF THE SOIL

Soil No.	Order	Group	Characteristics	Area (ha)
2	Amorphic	Lithosol	Very shallow soils, less than 25cm deep.	108,300
3B	Calcimorphic	Vertisol	Dark brown to black vertisols formed on basalt.	9,900
4E	Calcimorphic	Siallitic	Shallow to moderately shallow, brown or reddish brown clay	108,200
5E	Kaolinitic	Fersiallitic	Moderately deep to deep, reddish brown granular clays.	1,000
5G	Kaolinitic	Fersiallitic	Moderately shallow, grayish brown, coarse grained sands throughout the profile.	2,900
5M	Kaolinitic	Fersiallitic	Moderately shallow to deep, grayish brown, sands or loamy sands.	145,900
5S	Kaolinitic	Fersiallitic	Moderately shallow to moderately deep, reddish brown to grayish brown, silty clay loams and clay loams.	129,000
Total				500,200

Table 3-3 PRESENT LAND USE OF THE STUDY AREA

District	Ward	Cultivated Area			Grazing or Forest Area	Dense Forest Area	Total Area	Land Tenure Category
		(1)*	(2)**	(1)+(2)				
		(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	
Kadoma	No. 15	0	3,890	3,890	37,110	0	41,000	Large Scale CF
	Muzvezve I (No. 17)	910	5,310	6,220	85,700	480	92,400	Resettlement
	Sanyati (No. 20)	460	1,080	1,540	5,410	0	6,950	Communal Land
	Sanyati (No. 21)	2,150	370	2,520	3,930	0	6,450	Communal Land
	Sanyati (No. 22)	3,660	260	3,920	1,870	120	5,910	Communal Land
	Sanyati (No. 23)	6,410	110	6,520	4,660	130	11,310	Communal Land
	Sanyati (No. 24)	5,100	1,430	6,530	6,830	1,120	14,480	Communal Land
	Chenjiri (No. 25)	1,450	320	1,770	6,920	0	8,690	Small Scale CF
	Chenjiri (No. 26)	940	1,150	2,090	13,220	0	15,310	Small Scale CF
	Sachuru (No. 28)	0	2,450	2,450	32,750	0	35,200	Resettlement
Gokwe North	Nyaumngwe	0	1,100	1,100	11,900	0	13,000	Resettlement
	Copper Queen North	0	3,970	3,970	24,530	1,200	29,700	Small Scale CF
	Copper Queen Central	3,140	260	3,400	24,250	50	27,700	Small Scale CF
	Copper Queen South	4,080	0	4,080	15,160	4,660	23,900	Small Scale CF
	Makore I	510	7,370	7,880	8,770	150	16,800	Communal Land
	Makore II	3,710	3,640	7,350	6,750	0	14,100	Communal Land
Gokwe South	Chisina I	9,240	7,600	16,840	34,120	40	51,000	Communal Land
	Chisina II	4,010	8,140	12,150	47,570	380	60,100	Communal Land
Kwekwe	Mabara	0	3,730	3,730	13,170	0	16,900	Communal Land
	Sidakeni	0	3,190	3,190	11,110	0	14,300	Communal Land
Total		45,770	55,370	101,140	395,730	8,330	505,200	

Note : (1)* = Area to be irrigated by the proposed canal. (2)**Outside of the command area of the proposed canal.

Table 3-4 METEOROLOGICAL AND HYDROLOGICAL DATA RECORDS

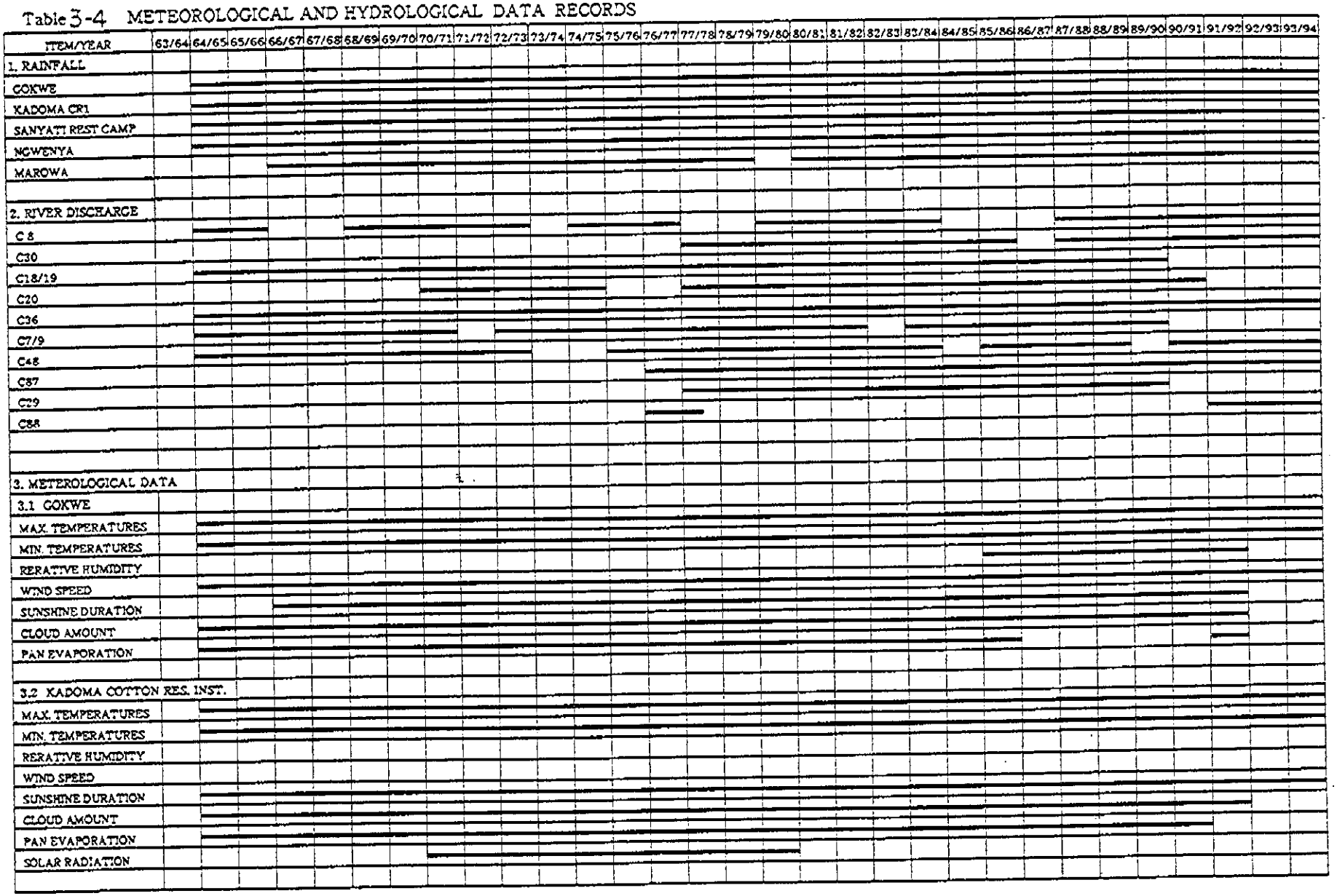


Table 3-5 RESULTS OF WATER QUALITY TEST

NO.	NAME	DATE (SAMPLED)	CATEGORY of WATER	DO (mg/t)	PH	COND (S/m)	TURB (mg/t)	TEMP (°C)
1	Copper Queen Farm No.165	93.12.28	Bor	4.7	7.3	0.03	10	27.6
2	Copper Queen Farm No.26	93.12.29	Bor	5.2	7.5	0.09	28	27.8
3	Copper Queen Farm No.342	93.12.28	Bor	5.3	7.5	0.06	44	27.6
4	Myamyama Res.	94. 1. 6	Res	3.9	7.7	0.00	192	27.9
5	Butete	94. 1. 9	Bor	2.9	7.0	0.08	8	25.4
6	Umnyati (Upper Streem)	94. 1. 9	Riv	4.7	8.1	0.00	273	25.5
7	Claw	94. 1.10	Res	5.0	8.5	0.01	13	26.9
8	Sanyati Farm No.61	94. 1. 9	Bor	3.5	7.4	0.05	31	24.2
9	Sanyati Farm No.110	94. 1. 9	Bor	3.3	7.9	0.08	84	24.4
10	Samambwa Clinic (KweKwe)	94. 1. 9	Bor	4.4	7.4	0.09	4	24.5
11	Ngondoma Res.	94. 1.10	Res	5.0	8.0	0.01	999	25.7
12	Mabura Dam	94. 1.11	Res	4.3	7.8	0.01	120	25.7
13	Mangwarangwara	94. 1.11	Res	4.6	7.8	0.01	118	25.5
14	Nyamakare	94. 1.11	Riv	3.6	7.2	0.01	19	25.2
15	Chisina P-20	94. 1.13	Bor	4.3	7.3	0.08	10	22.1
16	Chisina P-22	94. 1.13	Bor	3.8	7.2	0.12	6	22.1
17	Makore No.3	94. 1.13	Bor	4.9	7.4	0.12	6	22.3
18	Makore No.2	94. 1.12	Bor	4.4	5.7	0.00	73	22.1
19	Makore No.1	94. 1.12	SWL	4.0	7.2	0.08	5	22.4
20	Copper Queen Farm No.4	94. 1.12	Bor	3.3	7.4	0.09	19	22.3
21	Kudwu	94. 1.14	Riv	4.5	7.8	0.01	181	22.4
22	Chenvuri	94. 1.18	Riv	4.5	8.0	0.00	500	30.5
23	Benji	94. 1.18	Riv	4.5	8.2	0.00	140	30.6
24	Umnyati (Middle Stream)	94. 1.18	Riv	4.3	8.3	0.01	999	30.4
25	Mtanke	94. 1.18	Riv	4.4	8.1	0.00	999	29.7
26	Umnyati (Down Stream)	94. 1.19	Riv	4.8	7.9	0.00	295	23.6
27	Sakurugwe	94. 1.19	Riv	5.6	7.8	0.00	322	23.8
28	Muzuezue No.1	94. 1.20	Bor	3.4	7.2	0.10	25	23.7
29	Muzuezue No.2	94. 1.20	Bor	3.6	7.3	0.07	10	23.6
30	Muzuezue No.3	94. 1.20	Bor	2.9	7.3	0.10	28	23.8

Note) TURB : 999 means that turbidity of sample is over the range of measurement.
CATEGORY of Water : Bor ---> Borehole
SWL ---> Shallow well
Riv ---> River

Table 3-6 PESENT CONDITION OF IRRIGATION SCHEME

Item \ Ward	Sanyati 20	Sanyati 24	Mabura
1. Name	Takavingwa	Sanyati Estate	Ngondoma
2. Land Holding System	Communal	Estate	Communal
3. Irrigated Area	8 ha	960 ha	44 ha
4. Source of Water	Dam	River	Dam
5. Contents of System	Open Canal (concrete)	Pumps Night Storage Pipe-line	Main Canal (concrete) Night Storage Sec. Canal (concrete)
6. Irrigation Method	Flood	Sprinkler	Flood
7. Irrigation Period	All Year	All Year	All Year
8. Irrigation Frequency	6 hours/day 1 ~ 2 days/week	- -	8 hours/day 5 days/week
9. Rotation Block	3 block	-	5 block
10. Operating Organization	I.M.C.	A.R.D.A.	AGRITEX (I.M.C.)
11. Managing Organization	I.M.C.	Private Company	AGRITEX (I.M.C.)
12. Completion Year of Schemes	1986 ~ 1987	1974	1966 ~ 1968
Item \ Ward	Copper Queen South	Surisuri (Sanyati 15)	
1. Name	-	-	
2. Land Holding System	Commercial (Small)	Commercial (Large)	
3. Irrigated Area	40 ha	80 (15) ha	
4. Source of Water	Borehole	Borehole	
5. Contents of System	Pumps Night Storage Pipe-line	Pumps Night Storage Pipe-line	
6. Irrigation Method	Sprinkler	Sprinkler	
7. Irrigation Period	All Year	Rainy Season	
8. Irrigation Frequency	2~3 hours/day 3 days/week	- 4~5 days/week	
9. Rotation Block	-	2~3 block	
10. Operating Organization	Individual	Individual	
11. Managing Organization	Individual	Individual	
12. Completion Year of Schemes	1994	-	

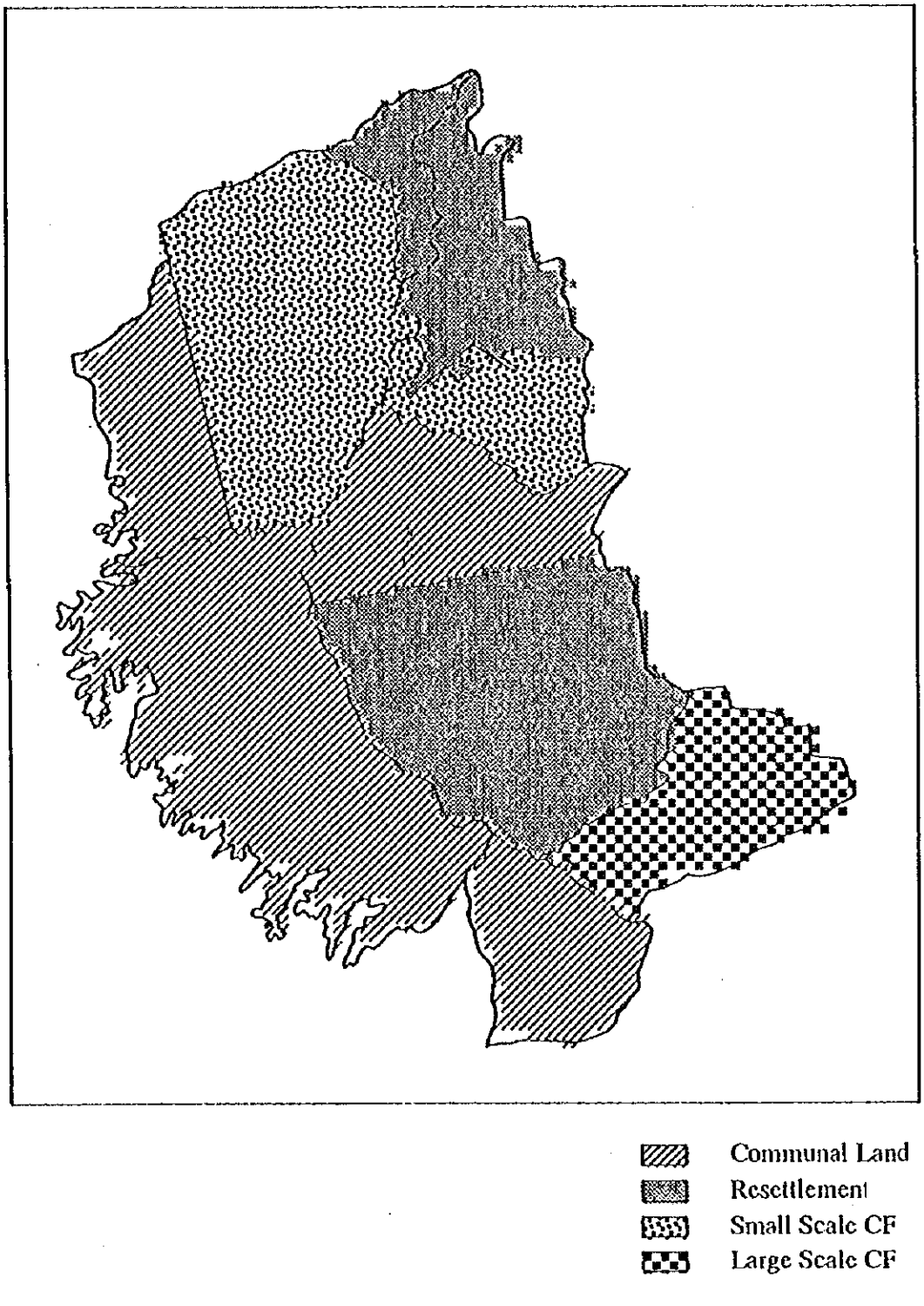


Figure 3-1 LAND TENURE SYSTEM OF THE STUDY AREA

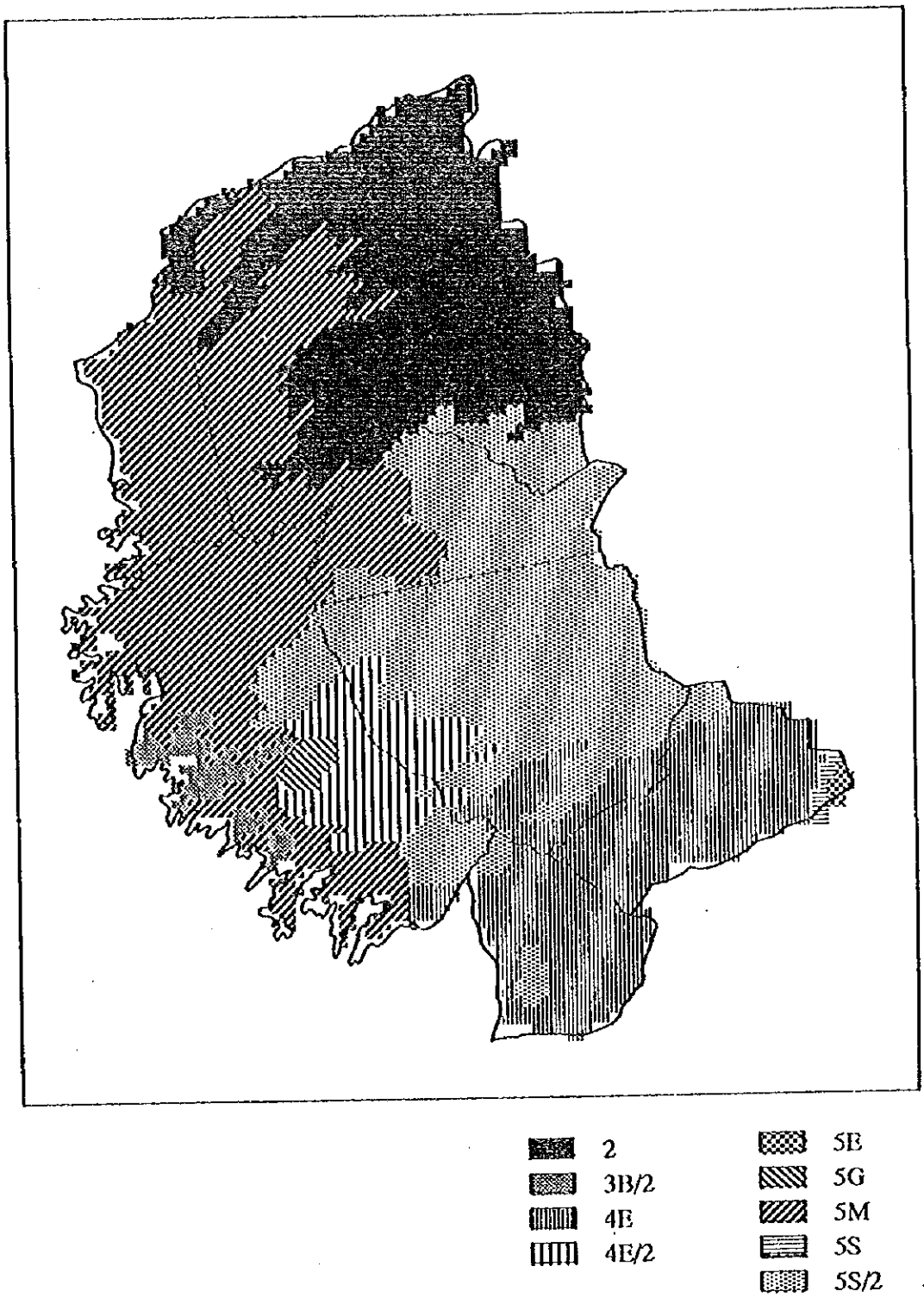


Figure 3-2 PROVISIONAL SOIL MAP OF THE STUDY AREA

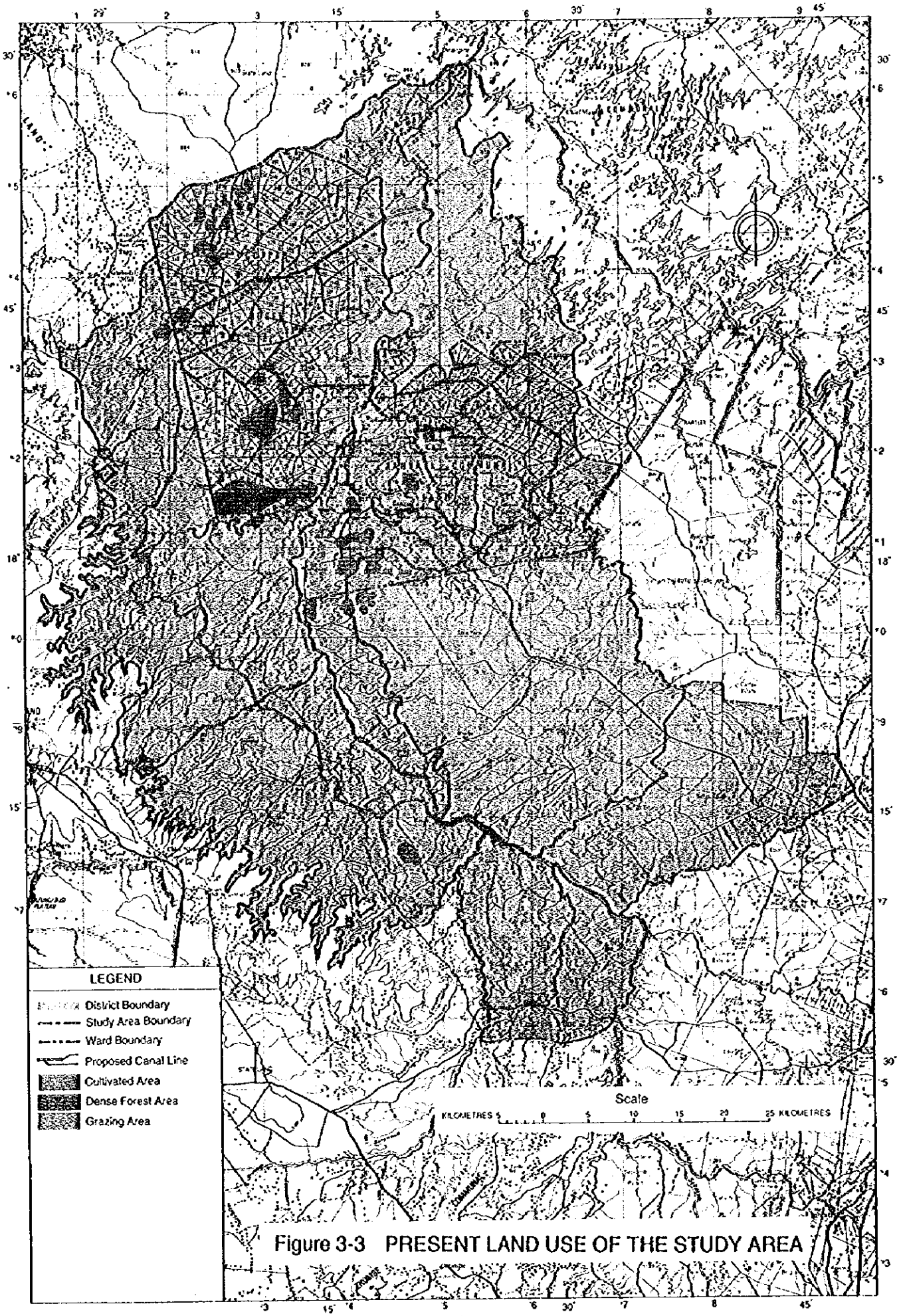


Figure 3-3 PRESENT LAND USE OF THE STUDY AREA

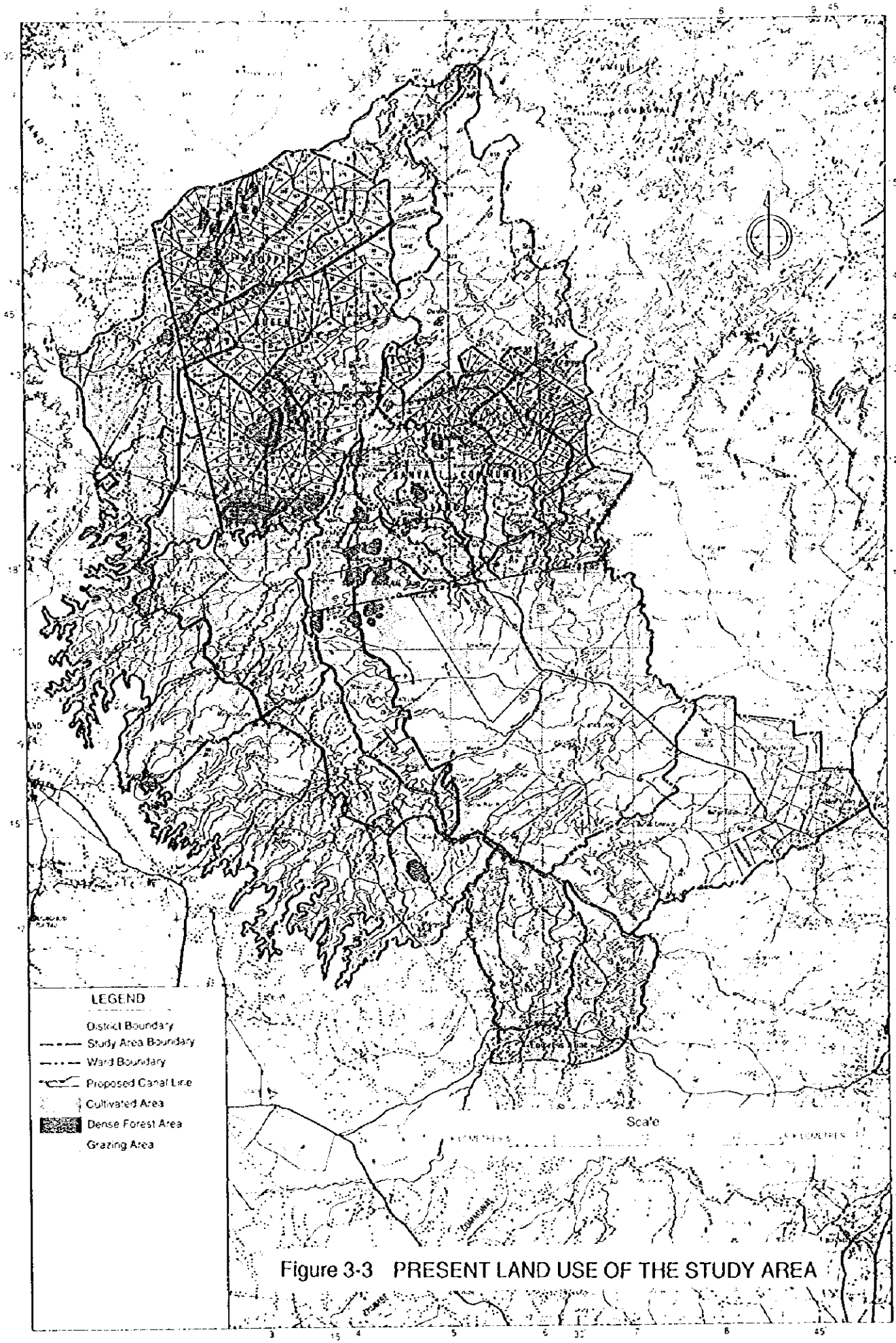


Figure 3-3 PRESENT LAND USE OF THE STUDY AREA

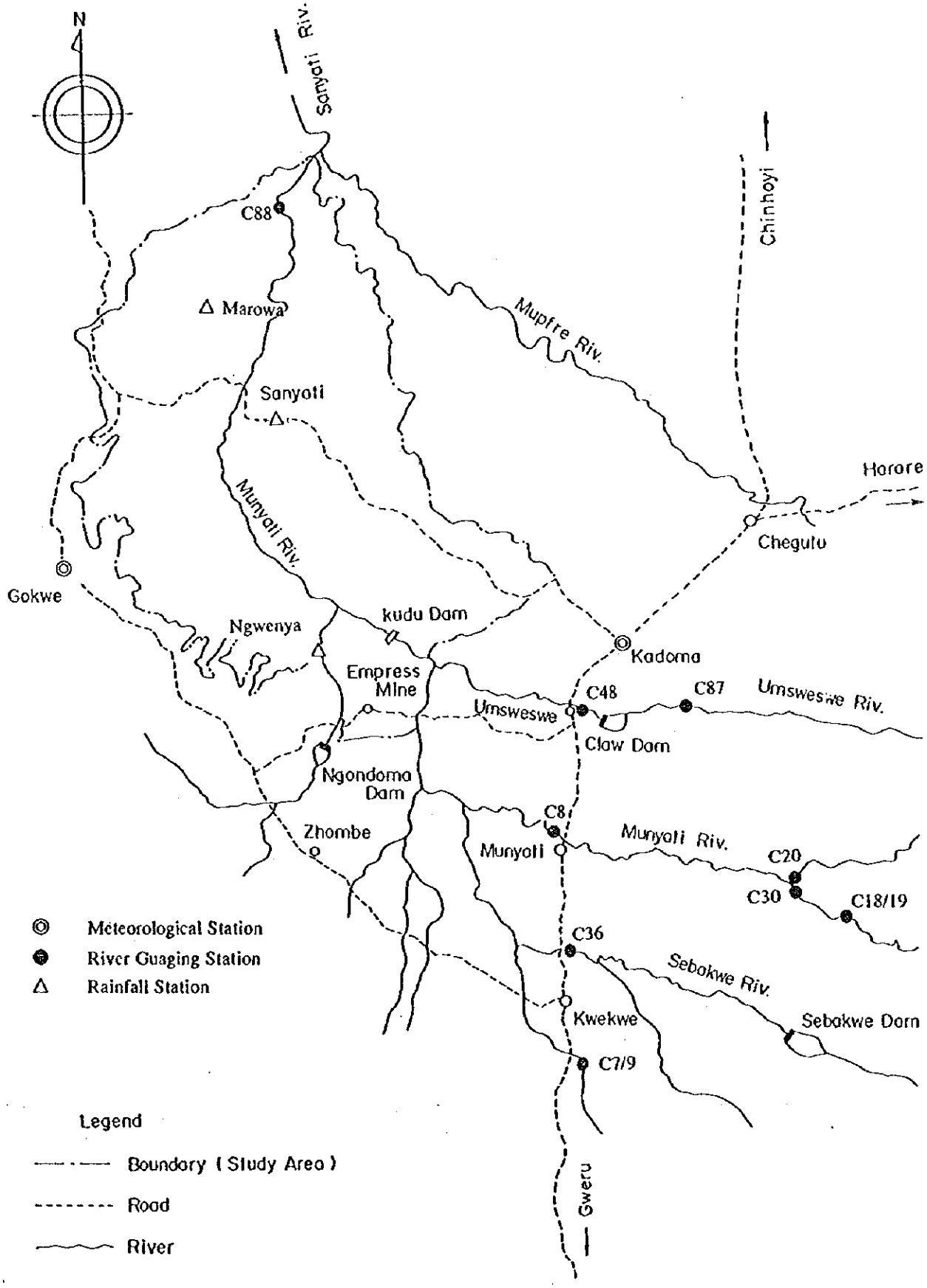


Figure 3-4 LOCATION OF METEOROLOGICAL AND HYDROLOGICAL GUAGING STATION

Mean Annual Meteorology from 1964 to 1993

Record Station	Rainfall (mm)	Temperature (℃) Max.	Min.	Relative Humidity (%)	Wind Speed (knot)	Sunshine (hour)
Kadoma	727.2	28.0	14.2	N.A.	4.7	8.5
Gokwe	736.2	26.6	14.6	57.3	4.1	8.6

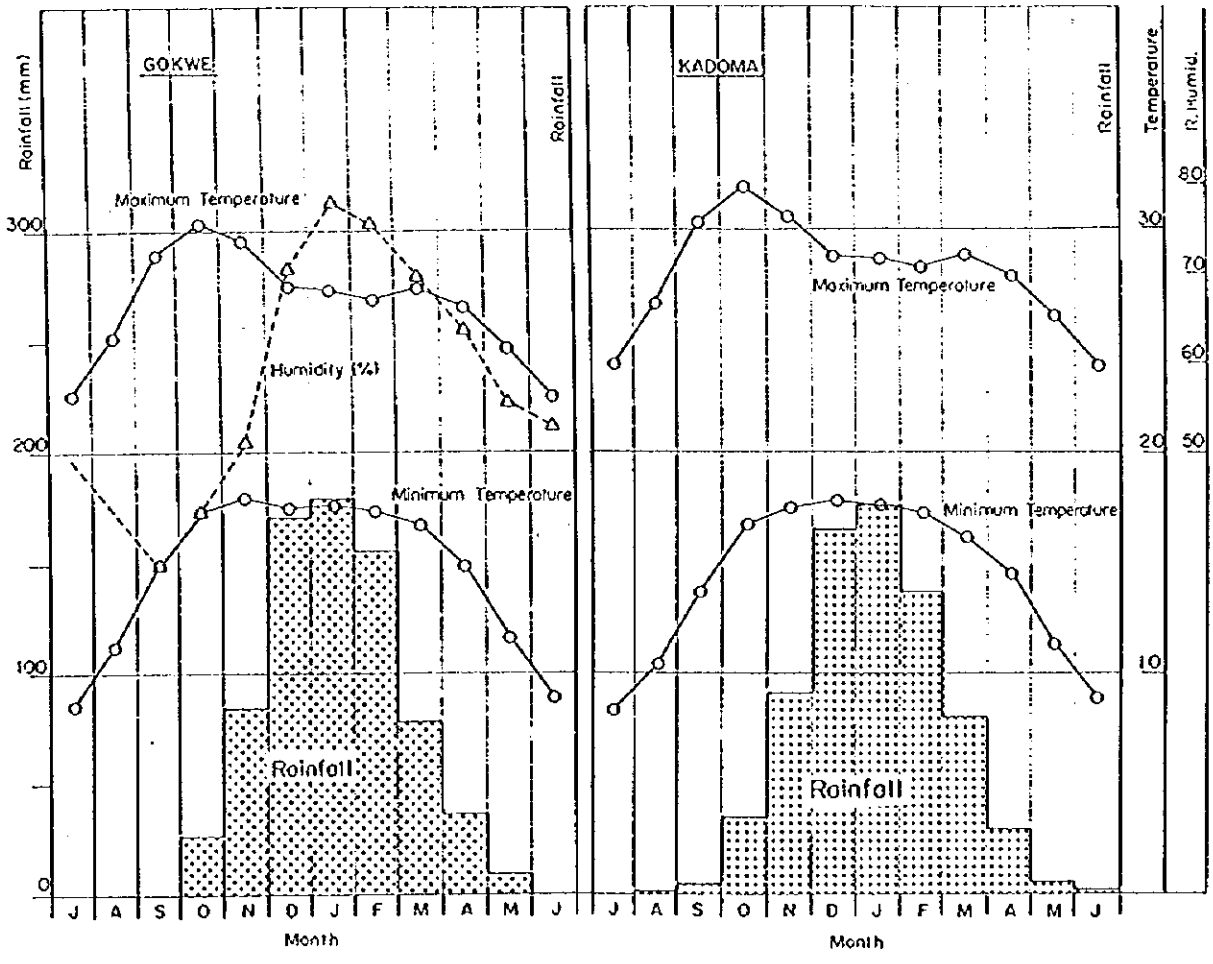


Figure 3-5 MEAN MONTHLY METEOROLOGY

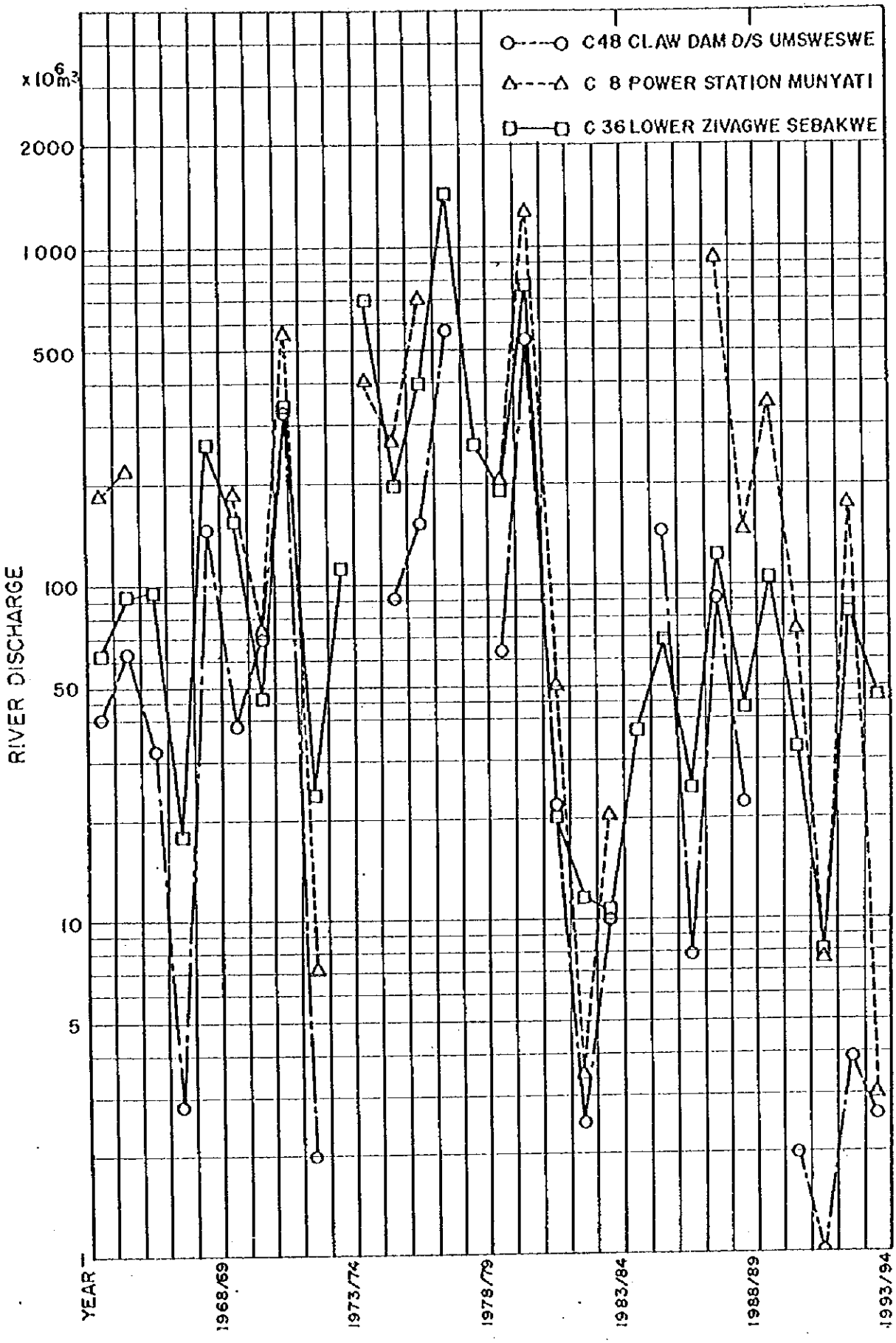


Figure 3-6 ANNUAL RIVER FLOW AT C48, C8 AND C36 GUAGING STATIONS

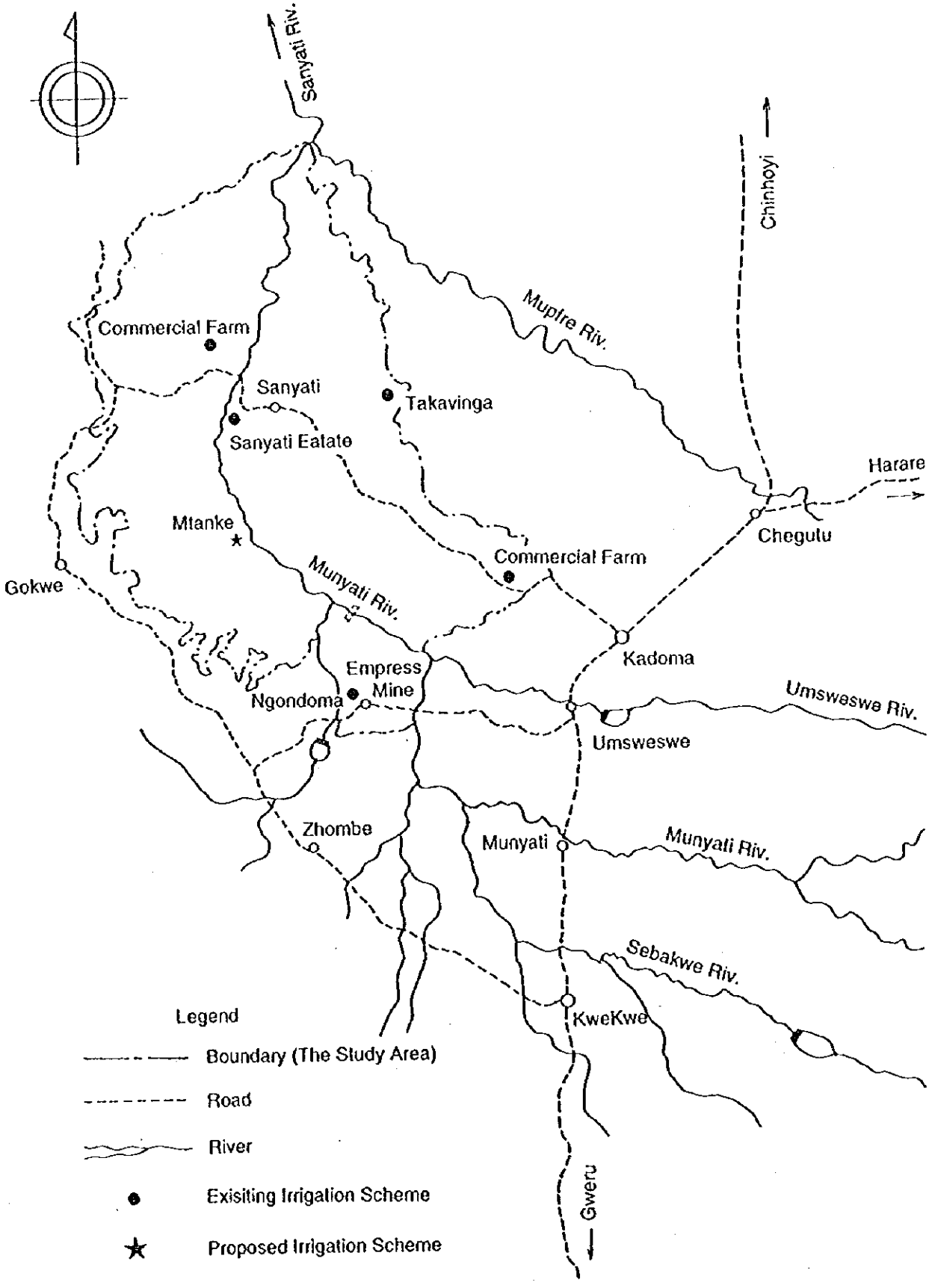


Figure 3-7 LOCATION MAP OF IRRIGATION SCHEME

CHAPTER 4

BASIC AGRICULTURAL DEVELOPMENT CONCEPT

CHAPTER 4 BASIC AGRICULTURAL DEVELOPMENT POLICY

4.1 Development Objective

In the agricultural sector of Zimbabwe before independence in 1980, the large scale commercial sector played a predominant role, and the government gave them support through development of water resources, etc. However, since the independence, the government has started to change its basic agricultural policy on the basis of recognition that domestic food security as well as the sustainability of the country's agriculture would be threatened without realization in the development of self-support by smallholder farmers in the communal and the resettlement areas and the small scale commercial farms who are majority of an individual farmers in the country.

Under such circumstances, the major objective of regional development aims to uplift smallholder farmers especially in the communal and the resettlement areas in the Study Area, and further to develop and promote the regional economy through self-support systems. The Zimbabwean government has placed its priority on the communal and the resettlement areas, the small scale commercial farms and lastly the large scale commercial farms in the order of allocation of Kudu Dam water. Hence, the master plan will be formulated by thoroughly examining efficient use of the limited water from technical, economical, social and environmental viewpoints.

4.2 Development Needs

In the Study Area, most of the farmers cultivate their land under rainfed conditions, and their productivity is quite low and unstable because the amount and pattern of rainfall fluctuates widely year by year. The unstable production further makes it difficult for farmers in communal and resettlement areas to secure financial resources for the next season's cropping through any of the financial institutions after failure to obtain an adequate harvest in a given year, due to scarcity or delay of rainfall.

Under such a situation, a vicious cycle occurs such that a number of livestock, especially cattle kept by them, need to be sold to repay outstanding debt or to secure the required expenses for the next season's cropping. This results in shortage of draft power for land preparation and weeding, and eventually in lesser crop production due to failure in implementing timely cultivation practices.

In small scale commercial farms in Copper Queen of Gokwe North District as well as those Ward No. 24 and 25 of Kadoma District, although they are managing their land well with a combination of crop farming and animal husbandry, cultivated land is also mostly under rainfed conditions.

Although the large scale commercial farms in Ward 15 of Kadoma District are operating their farms using groundwater for irrigation, they are critically facing a shortage of irrigation water in comparison to their land resources.

4.3 Development Potential

4.3.1 Human Resources

(1) Farmers

In the study Area, the total number of household and population are presently estimated at 17,613 and 105,268, respectively. Average density is about 21 per sq.km, which is a little bit lower than the national average of 27 per sq.km. It is roughly estimated that about 90 to 95 percent of the households are practising farmers.

(2) Extension officers and workers

AGRITEX is one of the departments in MOA with the responsibility for providing extension and technical services to all farmers including communal and resettlement farmers. Basically, there are 3 to 4 AEOs in each District and one AEO in each Ward. In the four Districts of the Study Area, there are 15 AEOs as well as 120 AEWs.

In addition to the extension and technical services, there are a

number of researchers at the Cotton Research Institute and training staff at the Cotton Training Centre in Kadoma. The Agricultural and Rural Development Authority (ARDA) a government parastatal is also promoting dairy production in Gokwe North district.

(3) Non governmental organizations

In addition to farmers and governmental officers, a number of non-governmental organizations are carrying out volunteer activities such as agricultural extension, water supply projects, livestock restocking projects and soil conservation. Such organizations include HPI (Heifer Project International), CC (Christian Care), WV (World Vision), DRC (Dutch Reformed Church) and WWF (World Wildlife Fund).

4.3.2 Land Resources

(1) Natural region

Zimbabwe is divided into five natural regions based on rainfall and other climatic factors:

According to the natural region map of the Study Area (Figure 4-1), around 84% of the area is classified as Region III. Regions II and IV cover 0.3% and 15.7%, respectively.

(2) Soil erodibility

Soil erosion is one of the major concern in agricultural management in Zimbabwe. It has been estimated that about 15% of agricultural land in the country is very severely eroded, 13% is severely eroded, 19% moderately eroded, and 53% is in relatively good condition. Most of eroded land is in communal areas, and most of the land in commercial areas is in good condition. Most soil erosion control activities in communal areas are concentrated on the construction of contour ridges, which is encouraged by AGRITEX.

Soil erosion hazard can be rated by factors contributing to erosion such as slope, vegetation cover, and erodibility of soil. The values of

individual factor are divided into several categories ranging from low to high erosion hazard. The Study Area was rated accordingly, and mesh maps of each individual factor were prepared. Then, these three maps (slope, vegetation cover and soil erodibility) were overlaid to create one map to evaluate the potential of soil erosion hazard of the area (Figure 4-2). Figure 4-3 shows that the Study Area is roughly divided into three different zones according to the degree of soil erosivity as follows.

Highly prone to soil erosion

The area lies in the south-west edge of the Study Area, which covers 407 sq.km (8.1%). The area is highly erosive mainly due to steep slope, and should be protected properly. The protection measures include preservation of natural vegetation, constructing contour bands, and tree planting.

Moderately prone to soil erosion

This area mainly occurs in Sachuru and Nyaurungwe resettlement areas in the north of the Study Area, and in the vicinity of the Munyati river in the southern part of the Study Area. The area is moderately erosive mainly due to rugged terrain, steep slope and shallow soils. Some of the area is covered by relatively sparse vegetation, which may also cause soil erosion. The area covers 487 sq.km (9.6%).

Little or not prone to soil erosion

The total acreage of the area is 4,158 sq.km (82.3%), which shows that most of the Study Area has little or is not prone to soil erosion. However, ordinary conservation measures such as contour bund will be recommended to protect farm lands.

(3) Land restriction for irrigation

The assessment of the suitability of land for irrigation is mainly based on the soil profile morphology and the landscape in which the soil occurs. The major soil characteristic which affects the suitability for irrigation is water retentivity of the soil. In this study, water retentivity of soils was estimated from their texture. Other factors such as slope, vegetation density, and the potential of soil erosion hazard were also incorporated in the assessment. The Study Area was rated according to the values of these individual factors in a similar manner with soil erosion rating. Figure 4-4 shows that the Area is roughly divided into four different zones according to the degree of the limitation for irrigation as follows:

Very restricted area

The area lies to the south-west edge of the Study Area, which covers 310 sq.km (6.1%). The major limitation of the area is high risk of soil erosion mainly due to steep slope. The natural vegetation of the area should be preserved to avoid further land degradation.

Moderately restricted area

This area mainly occurs in Sachuru and Nyaurungwe resettlement areas in the north of the Study Area, and in the vicinity of the Munyati river in the southern part of the Study Area. The total acreage of the area is 487 sq.km (9.6%), which has moderate limitation for irrigation mainly due to rugged terrain, steep slope and shallow soils.

Slightly restricted area

This area is mainly scattered in Copper Queen area and the western part of Sanyati communal land, covering 301 sq.km (6.0%). The major limitation of the area is relatively low water retentivity due to the coarse structure of the soils.

Little to no restricted area

Most parts of the Study Area except for the above mentioned restricted areas has little to no limitation for irrigation. The area covers 3,954 sq.km (78.3%).

4.3.3 Water Resources

(1) Munyati River

As previously mentioned, the Munyati river has a mean annual flow of about 600 million cu.m over the last 30 years. However, it shows wide fluctuation when the average annual flow is compared over 10 year intervals: 505, 950 and 330 million cu.m for years 1964/65-1973/74, 1974/75-1983/84 and 1984/85-1993/94, respectively.

In the main stream of Munyati, DWD has completed the detailed design for Kudu Dam in 1993, of which purpose is supply of irrigation water to lowland in mainly Sanyati, Copper Queen, Chenjiri and Gokwe as well as urban water supply to Kadoma and Kwekwe including industrial uses. The dam site is located about 70 km westward from Kadoma, and 1.5 km upstream from the conjunction point of Munyati and Ngondoma rivers. Main feature of Kudu Dam are indicated in the following:

Design of dam

- Dam type: Rockfill
- Dam Height: 72.7 m
- Dam Length: 860 m
- Saddle Dam Length: 875 m
- Designed flood: 2,122 cu.m/s
- Embankment Volume: 8.005 MCM

Design of Reservoir

- Catchment Area: 17,520 sq.km
- Surface Area at FSL: 7,800 ha
- Total Storage: 1,551.4 MCM
- Full Capacity: 1,491.4 MCM
- Live capacity: 1,426.9 MCM
- 10 % yield: 380.0 MCM
- FSL: 947.0 m
- Outlet EL: approx. 905.0 m

(2) Tributaries of Munyati River

In the Study Area, feasibility studies for medium size dams in the communal lands were done by Dangroup International, Denmark in the Midlands Province in 1984 and by Energoprojekt, Yugoslavia in the Mashonaland West Province in 1986, respectively (See Table 4-1 and Figure 4-5). According to these studies, while one and seven dam sites were identified in Mashonaland West and Midlands provinces, respectively, most of them do not have enough potential as water sources, because although each dam has a big storage capacity, its catchment area is too small. And some dam sites are located in inferior geological conditions. It is rather difficult at this moment to find out additional potential dam sites from the existing topographic map with scale of 1/50,000, due to the fact that the contour interval is as wide as 20 meters.

Based on these reports, DWD selected Sanyati-2 Dam and Mtanke Dam, and prepared the design reports for these dams. Summaries are described as below:

Sanyati-2 Dam

The site is about 70 km north-west of Kadoma along the Kadoma-Sanyati road in Mashonaland West Province. (Map ref: 1729c4 and Grid ref: QL 604131). The dam located on the Seki river will be used to irrigate about 36 to 65 ha for communal area, domestic water supply and livestock and to nearby communities and business centre.

- Dam type: Homogeneous earth fill
- Dam Height: 16 m
- Live capacity: 3.87 MCM
- 10 % yield: 0.62 MCM

- 25 % yield:	1.14 MCM
- Irrigable land:	36 ha for 10 % risk level 65 ha for 25 % risk level

Mtanke Dam

The site is about 48 km north-west of Empress Mine which is off the main Gokwe-Empress Mine tarred road in Midlands Province (Map ref: 1829 A1 and Grid ref: QK 365853). Mtanke dam will be used to irrigate about 105 ha of land by sprinkler irrigation and also supply water for Mtanke Clinic, Mtanke Primary and Secondary Schools, etc.

- Dam type:	Central impervious earth fill
- Dam Height:	22 m
- Live capacity:	4.17 MCM
- 10 % yield:	1.70 MCM
- Irrigable land:	105 ha approx.

4.3.4 Socio-Economic Resources

(1) Financial resources

The supply of credit by AFC for the purchase of agricultural inputs and assets is one of the critical socio-economic resources needed to increase the production base of farming. The AFC offers short-term loans for procurement of input materials and has a medium-term loan scheme for purchase of equipment and machinery, for both of which interest rates are lower than those of private financial institutions.

Table 4-2 indicates the number of borrowers and the value granted by AFC in the Study Area of Gokwe North, Gokwe South and Kwekwe Districts. As for the short-term loan, the total number of borrowers and the total value granted by AFC to 710 households was Z$ 812.0 thousand in 1994. As for the medium-term loan, the total number of borrowers and the total value granted by AFC to 6 households was Z$ 19.4 thousand in 1994. In this way, the total financial resources provided by AFC was Z$ 831.4 thousand in 1994.

(2) Marketing resources

The marketing of agricultural products is also of socio-economic importance since this enables farmers to gain cash income by selling the products to markets. Before the introduction of the Economic Structural Adjustment Program (ESAP), the marketing as well as prices of all agricultural products were completely controlled by the state-owned parastatals such as CMB (Cotton Marketing Board), GMB (Grain Marketing Board), DMB (Dairy Marketing Board) and CSC (Cold Storage Commission). However, ESAP accelerated the deregulation of marketing and the removal of price controls as well as the commercialization of some of the parastatals.

For cotton marketing, CMB has just been commercialized into COTTCO (Cotton Company of Zimbabwe) in 1994, and other private ginners and spinners have been allowed to buy raw cotton directly from farmers. The CSC is now the Cold Storage Company after also being commercialized but faces stiff competition from private buyers.

As for maize, while GMB still remains a parastatal and maintains floor prices, marketing regulations have been eliminated. In spite of dominant positions as the primary trader of maize, GMB are also obliged to compete with private traders.

In this way, the commercialization and deregulation of marketing and prices accelerated competition between parastatals/ex-parastatal companies and private buyers. As a result, this competition is expected to benefit small holder farmers by offsetting the price differentials in agricultural products between producer's prices and open market prices. The increase from fixed producer's prices to market prices is one of the most promising socio-economic resources to increase the cash income of small holder farmers.

(3) Input materials

The input materials available in the Study Area are also important socio-economic resources, since they affect the level of crop yields. According to AGRITEX, it is estimated that the factors affecting yield of

maize are: a) fertilizer (61.5%); b) high-yield variety seed (13.8%); c) chemicals for weed control and pest control (12.3%); and d) others (12.4%). In other words, if input materials would be properly supplied to small holder farmers, there are enough socio-economic potentialities to improve the level of crop yield. The input materials are usually supplied through private companies owned by large-scale commercial farmers or foreign multinational companies.

4.4 Development Constraints

Against the development needs and potential so far identified in the above, the following constraints are taken into consideration for formulation of development scenarios:

4.4.1 Physical Issues

The Lower Munyati River basin originally did not have any human population because the area was infested by Tsetse fly. There are many cases of communal lands being formed since 1950's when extermination of Tsetse fly occurred. In the communal lands, a Chief controls a certain expansion of area with authorization in distribution of arable land for cultivation, maintenance of public peace and order, and jurisdiction. Farm size ranges between three and six hectares, and are often scattered with distances ranging several ten to hundred meters from each other. Similar to the resettlement land, most of dwellers in the communal land were forced to transfer from their old places when commercial farms were established. People in the Study Area originated from various places such as Masvingo and Matebeleland.

In most of the resettlement areas, each farmer occupies two to four hectares of cultivated land. Farmers are also given a permit for grazing land. Homesteads and arable land in resettlement schemes are not usually scattered but are grouped together. There are two types of resettlement farmers. Firstly, farm workers on commercial farms were sometimes allowed to settle the present farm. Secondly, farmers who could not receive any land in communal lands due to population increase, were moved and settled on commercial farms after submitting an application. In addition to these resettlers, there exist certain groups who already

squatter on abandoned commercial farms.

In the communal and the resettlement areas, a plot of existing cultivated land is, generally, quite small and scattered here and there, and topography between one plot to another is rather undulating. Thus it is considered quite difficult to convey irrigation water to each plot from the viewpoints of the huge cost to be required for construction of irrigation canal network as well as complicated water management that would be required by such a canal network. It will, therefore, be necessary and inevitable to relocate and consolidate the existing farming plots. It is considered more advantageous taking into consideration future infrastructure development that the irrigation command area should be distributed along or near the main/secondary canals, and new community development should be made around the irrigation command area.

4.4.2 Technological Issues

In order to stabilize the present agricultural production under rainfed conditions, it is considered a prerequisite to introduce irrigated agriculture in order to stabilize production. However, most farmers in the communal and the resettlement areas do not recognize the word "irrigation". While the word irrigation is translated into the Shona language as "kudiridza", it is rare for the farmers to use the word in daily conversation. From these observation, it is considered that most of the people in the Study Area do not have experience or knowledge about irrigated agriculture.

On the other hand, sprinkler irrigation was introduced and practiced at the Cotton Research Institute and the large scale commercial farms near Kadoma town, and the ARDA farm located in part of the Study Area (Sanyati), but knowledge or knowhow on fundamental terms such as unit crop water requirement and irrigation interval, is lacking.

Recently, Ministry of Health recommended the growing of vegetables in order to improve the nutrition of local people. Many villages are preparing collective farm gardens by using existing small ponds or wells, in which water is carried by a bucket and supplied to furrows. This can not be categorized as a sophisticated irrigation method. Only in two

places with medium-size dams, a gravity irrigation is being carried out under guidance of AGRITEX's extension workers, i.e. Ngondoma and Takavingwa.

People in Zimbabwe are different from those in Middle East and Northern African countries where people have made various efforts to develop irrigation since ancient time. Because irrigation has never been required in Zimbabwe for a long time, knowledge on irrigation such as land development, water rights, irrigation methods and interval, and so on, is not widespread. For example, when a gravity irrigation system is to be used on-farm level, land levelling of the existing cultivated land will be required. On the other hand, in the case of sprinkler system, it would require a considerable amount of initial investment as well as operation and maintenance costs. According to the field survey in Zimbabwe, it should be pointed out that a few of concerned personnel understands the said premises sufficiently.

4.4.3 Socio-Economic Issues

(1) Financial constraints

Although the short-term and medium-term loan schemes are available for small holder farmers, there are three financial constraints for these AFC's schemes. Firstly, the financial sources for communal, resettlement and small scale commercial farmers are extremely limited. Table 4-3 indicates the number and value of loans granted by AFC by type of land holding system. According to these data, while the value of loans for large scale commercial farmers increased, that for small scale commercial farmers was stagnant in the 1990s. In fact, the total value granted by AFC in the study area has been drastically decreasing from Z$ 2,209.1 thousand in 1990 to Z$ 831.4 thousand in 1994.

Secondly, although the interest rate is favorable for communal and resettlement farmers, it is still high for repayment. The interest rate for the short-term loan scheme for small holder farmers which is currently 22.5%, is much higher than the annual growth rates of nominal prices of maize and cotton, which are 8.80% and 8.77%, respectively.

Thirdly, almost all farmers complained that the medium-term loan to buy machinery is not available without sufficient assets. In fact, out of Z$ 831.4 thousand, which is the total value granted by AFC in the study area in 1994, only 2.33% of them is medium-term loan provided to small holder farmers.

(2) Marketing constraints

Although the commercialization and deregulation of marketing and prices were expected to accelerate competition between parastatals/ex-parastatals companies and private buyers, the fact is that the prices offered by these private buyers are reported to be well below the official prices by GMB, COTTCO, DZL and CSC due to lack of transportation in isolated areas and lack of alternative outlets. In other words, the main constraint in marketing is lack of transportation which causes buyer's market even under competitive free markets. In fact, the transportation costs for a bale (200kg) of cotton and a bag (50kg) of maize are Z$ 30 and Z$ 7, respectively.

(3) Constraints for input materials

The small holder farmers, especially, communal farmers had low-level amount of input materials such as fertilizers, chemicals and high-yield seed varieties. Taking an example of fertilizers, Table 4-4 indicates the comparison in dosage of fertilizers by type of land holding system. It clearly shows that there is a sizable gap between small holder farmers and large scale farmers in the amount of input materials per unit area, which leads to a big differential in the yield of major crops.

4.4.4 Local Administrative and Institutional Issues

(1) Cooperation among agencies concerned

The Study Area belongs to the Mashonaland West province on the right bank side of Munyati river and to the Midlands province on the left bank side. According to the field survey, it seems that there are bureaucratic problems or sectionalism in various ministerial agencies. In addition,

there exist differences in level of institutional set-up as well as level of recognition on the proposed project among local offices of the concerned ministry and provincial offices as well. Therefore, for the successful implementation of the master plan, it is necessary to formulate a consistent policy in relation to construction, management, operation and maintenance of project facilities, land improvement works, agricultural extension, agricultural credit and so on. To cope with such requirements, it may require good coordination among governmental agencies concerned at the central and local levels not only horizontally but also vertically.

(2) Agricultural Extension Services

As mentioned before, extension workers are stationed at each Ward which on an average comprises about 6 villages. The number of farm households in each Ward varies widely. According to AGRITEX, in Zimbabwe, about 1,750 Ward level extension workers are providing services to some 850,000 farm families overall, a ratio of about 1 to 485. In this way, extension workers are forced to cover wider areas and a large number of farm households. In fact, taking an example of Kadoma District, some Wards do not have their own AEWs.

In addition to this lack of manpower, there are two other constraints for extension workers. They suffer from lack of communication and mobility for extension services. Taking an example of Kadoma District, although two pickup trucks are available for AEOs, two AEWs do not have motorcycles and there are only three sets of wireless communication equipment for 23 AEWs. This lack of communication equipment and mobility prevents AEWs from providing prompt technical extension services.

(3) Farmers' organization

In the Study Area, solidarity in the community is rather weak and there exist none of a wide range farmers' organizations, especially in the communal and the resettlement areas. It is a prerequisite for the successful implementation of the project, to organize beneficial farmers to become members of a water user group and an agricultural cooperative

so that they can work together on several activities such as operation and maintenance of project facilities, acceptance of agricultural extension, request for agricultural credit and guarantee for loan, collective purchase of farm input as well as sale of farm products. The formation of agricultural cooperatives is regarded as critical.

4.4.5 Issues on Data and Information

In either the level of the master plan study or the feasibility study, basic data and information are prerequisite to formulate a proper irrigation plan which should be technically sound.

In this study, detailed topographic information is lacking. The topographic map with a scale of 1/50,000 and contour intervals of 20 meters, is presently available. Although an aerial photograph is available, which was taken in 1986, it is considered that physical condition has changed during the last 10 years since the photos were taken.

In addition, it is recognized that more reliable and precise hydrological data will be required, especially, data on the discharge of major tributaries of the Munyati river.

4.5 Development Scenario

4.5.1 Basic Concept

The development scenario presently formulated would include cases with Kudu Dam (Scenario A) and without it. The latter is further divided into a case with consideration of any water resources development (Scenario B-1) and without it (Scenario B-2). The basic concept for the development scenario is presented in Table 4-5.

In addition to the said three scenarios, a scenario incorporating the role of regulating ponds by medium size dams in the tributaries will be examined for the scenario with Kudu Dam. Furthermore, level of farm management and technology differ by category of farming system, therefore, it is inevitable to formulate an agricultural development plan by setting

different development target with respective level as shown below:

Dev't Level	Development Target	Development Target: Communal/ Resett't Land	Development Target: Small Scale Comm'l Farm	Development Target: Large Scale Comm'l Farm
1	Increase & Stabilization of Wet Season Cropping	Short/ Middle	Short	-
2	Change from Subsistence to Cash Crops	Middle/ Long	Short/ Middle	-
3	Introduction of High Value Added Agriculture	Long	Middle/ Long	Short/ Middle

Target Range: Short: 3 - 5, Middle: 5 - 10, Long: 10 - 20 years

In order to promote sustainable agricultural development in the Study Area, it is considered a prerequisite to introduce a staged development approach towards realization of the development target as set forth in the above. In addition, since each development scenario has respective development period, step-wise implementation of the scenario which has shorter development period, shall be deployed until the time when the other scenario(s) will be realized.

4.5.2 Development Framework

(1) Scenario A (with Kudu Dam)

1) Target year and projection of farm numbers

After completion of the Master Plan Study, it would take about five years for a feasibility study and a detailed design, and 10 years for construction works (5 years for the dam and 10 years for the main irrigation network as well as on-farm level irrigation facilities). In this connection, the entire project facility would be under operation in year 2010, which is being set at the target year for this scenario. During the period until the project facilities are completed, it is considered necessary to promote regional development by taking into account implementation of the other two scenarios.

For formulation of development scenarios, population and farmers in

the Study Area in year of 2010 was estimated by four types of land holding. In this analysis, it is presumed that present family size in each land holding system would be unchanged, and population growth rate of the rural area in the two provinces over 10 years from 1982 to 1992, is being applied. In the communal and the resettlement areas, the percentage of farmer against total household is considered 95 percent. Table 4-6 shows the results of the forecast. The present number of farmers including those employed in the large scale commercial farms will increase from 16,870 to 26,794 in 2010.

2) Land use planning

Based on the land resources potential, the study area was roughly divided into two different land categories; namely conservation area and utilization area (Figure 4-6). Each category is further sub-divided into two zones according to their potential.

a) Conservation areas

Major constraints of these areas are steep slope, rugged terrain and relatively high risk of soil erosion. The natural vegetation of these areas should be preserved to avoid further land degradation. Some part of the zone-1 will, however, be utilized as cultivated land or grazing land depending upon their conditions.

b) Utilization area

The zone-1 has higher development potential, followed by the zone-2 in terms of land resources. Most of the areas are suitable for agricultural development. By overlaying Figure 4-6 and Figure 3-3 (present land use map), it is obvious that most of the cultivable area currently lies in these two zones.

3) Allocation of Kudu Dam Water and Irrigable Area

a) Allocation of Kudu Dam Water

After allocating urban/industrial water of 60 MCM for Kadoma and

Kwekwe in the target year of 2020 from water to be developed by Kudu Dam (380 MCM at 10% Risk Level), the remaining could be utilized as irrigation water. In accordance with AGRITEX's guideline, allocation of water should be based on the following:

Utilization	Amount (MCM)	Allocation (%)
Urban/Industrial Use	60.0	15.8
Irrigation Use		
- Communal/Resettlment	188.2	49.5
- S.S.C.F.	75.3	19.8
- L.S.C.F.	56.5	14.9
- Sub-total	320.0	84.2
Total	380.0	100.0

b) Irrigable Area

On the basis of available amount of water, proposed cropping pattern and other necessary factor on irrigation planning, irrigable area has been calculated as follows:

Risk Level	Irrigable Area
25 %	35,000 ha
10 %	25,000 ha

4) Allocation of farmland and relocation in communal/resettlement areas

a) Irrigated area

Coping with Zimbabwean governmental policy, each farmer within the irrigation command area could be allocated one hectare of irrigable area, aiming for full-time irrigation. And in order to secure 14,700 irrigated farmers, about 5,000 farms shall be involuntarily relocated into the irrigation command area as shown below:

Number of Farms to be Relocated into Irrigation Area
(not including those people from Kudu reservoir area)

	With Kudu Dam Total Farms	Without Kudu Dam Relocation	Without Kudu Dam Total Farms
1. Inside I. C. A.			
- Existing farmer	5,473	5,070	10,503
- New farmer	3,197	0	3,197
- Total	8,670	5,070	13,700
2. Outside I.C.A.			
- Existing farmer	8,649	(-)5,070	3,619
- New farmer	5,158	0	5,158
- Total	13,807	(-)5,070	8,777

(Note: I.C.A. : Irrigation Command Area)

b) Non - irrigated area

For the reasons of topographical condition, social aspect arising from land holding system and so on, those farmers of about 3,600 who could not enjoy an irrigation benefit, are guaranteed to keep the same farm size at present. In cases where the size is below 4.0 ha as well as for newly increased farmer of about 5,100, farm size of 4.0 ha is also guaranteed.

5) Relocation of people in Kudu Dam reservoir

The distribution of population within the project area is significant. The right bank of the Munyati River within the basin falls within the Umsweswe I Resettlement Area which is not settled. Some three villages that were originally planned within the flood basin when resettlement in the area began during the early 1980s where never implemented. The nearest village is Village 16 which is some 5 km east of the anticipated water line for the reservoir. On the other hand, it is on the left bank of the Munyati River in Zhombe communal area that people will have to be relocated. It is estimated from field observations that some 600 families will be displaced from the basin that is going to be flooded by Kudu Dam, most of them from the valleys of the Koronika and Mangwarangwara Rivers. In addition, taking into consideration people to be included in the buffer zone as a national park designated by DNPWLM, the total number of people to be relocated would be more or less 1,000 families.

In order to sufficiently compensate those peoples to be relocated, it is planned to locate them inside a proposed irrigation command area. In this regard, about 1,000 ha of farmland will be newly reclaimed in the Umsweswe I Resettlement Area, in which a part would be under an irrigation command area within the three resettlement area in the Study Area.

(2) Scenario B-1 (Medium size dams)

1) Target year

In this scenario, agricultural development will be promoted by constructing several medium size dams on the tributaries of Munyati river. The target year of this scenario is being set in year 2005 taking into consideration the required period of 10 years for a feasibility study, a detailed design and construction works.

2) Land use planning

Fundamentally, the same planning as with Scenario A would be applied.

3) Irrigable area by medium size dams

Providing an annual water requirement of 1,100 mm per ha which is computed on the basis of the proposed cropping pattern applied to Scenario A, the irrigable area works out at 331 ha using the water from eight medium size dams identified.

4) Allocation of farmland for farmers in communal/resettlement areas

Fundamentally, similar conditions as with Scenario A would be applied.

(3) Scenario B-2 (No Dam)

1) Target year

Scenario B-2 is fundamentally aiming for regional development without depending on irrigated agriculture, and the target year is being

set at the year 2000, taking into consideration five years for further study and implementation. The scenario is also a development plan which would be implemented not only for the period until realization of the other two scenarios with a water resources development scheme, but also for those people who would not enjoy benefits arising from the water resource development in the other two scenarios.

2) Land use planning

Fundamentally, same planning as with Scenario A would be applied.

3) Allocation of farmland for farmers in communal/resettlement areas

Allocation of farmland to those farmers in both the communal and the resettlement areas is as same as in the non-irrigated land of Scenario A.

4.5.3 Development Impact

In order to compare the three development scenarios, irrigable area and change in the land use have been analysed by each scenario, taking into consideration the target year and the farm number set in Scenario A as well as other development framework set in the respective scenario. The results are shown in Table 4-7 and Figure 4-9. In Scenarios B-1 and B-2, it is considered necessary to convert about 30,000 to 35,000 ha of presently grazing/bush lands into cultivated land in order to secure farming plots for newly increased farmers.

On the other hand, in Scenario A, it would be able to convert about 24,000 ha of the presently rainfed cultivated land into grazing land or forest land. Even in case of 1/10 probability analysis in the water balance study, about 10,300 ha of land in both the small and the large scale commercial farms could be irrigated after providing the required irrigation water for the communal and the resettlement areas.

4.5.4 Issues and Necessary Measures

In Scenario A, the main theme is to promote a large-scale development of irrigated agriculture for smallholder farmers in the

communal and resettlement areas. Thus, the scenario includes various unknown factors as well as issues to be solved in future, because the proposed Kudu Dam and irrigation facilities would require a quite huge investment and long development period. On the other hand, in Scenario B-1, eight medium-size dam have been selected with irrigable area of only 331 ha, and most of the cultivated area will remain under rainfed condition. Also, the main theme of Scenario B-2 is an agricultural development under rainfed condition, of which a certain development approach will be applicable in the transition time before realization of the scenario with water the water resource development as well as those people who could not enjoy any benefit arising from development of irrigated agriculture.

Therefore, Table 4-8 indicates problems and issues to be considered in the formulation of a basic agricultural development plan for each development scenario. Furthermore, ten items of the project component have been selected towards solving the said problems of issues, which are: (a) research, experiment and extension of regional farming technology; (b) strengthening of agricultural extension services; (c) marketing development; (d) activation and establishment of farmers organization; (e) farmers' participation; (f) improvement and strengthening of agricultural crediting system; (g) rural infrastructure development; (h) water resource and irrigation development; (i) land reclamation and soil conservation; and (j) management, O & M of project facilities (See Table 4-9).

Table 4-1 Summary of the Potential Medium Dam Sites in the Study Area

No.	Hydrologic Zone	River Name	Grid Ref.	Dam Height	Dam Length	Storage Capacity	YIELD	Estimated Irrigable Area	Remarks
				m	m	1000 m^3	1000 m^3	ha	
D1	CUN 1	Ganyungu	QL 251064	8.6	300	480	*200	***18	No rock visible
D2	CUN 1	Nyarupakwe	QL 276015	10.2	200	750	*120	11	No rock visible
D3	CUN 1	Nyarupakwe	QK 266977	11.8	120	660	*50	4	geologicaly no good
D4	CUN 1	Nyamachene	QK 317998	9.2	125	170	*90	8	Existing dam 3km upstream.
D5	CUN 1	Mtanke	QK 365853	22.0	133	4100	**1700	105	
D6	CUN 1	Gwanyika	QK 361797	13.1	500	1590	*940	80	
D7	CUN 1	Njerere	QK 450714	15.9	400	1090	*590	50	
D8	CUN 1	Seki	QL 604131	16.0	432	3,870	**620	55	
	Total							331	

* : 20% risk level

** : 10% risk level

***: water requirement for irrigation is estimated at 1,100mm/ha/year

Table 4-2 The Number of Borrowers and Value Granted by AFC

AREA	YEAR	Short-Team		Medium-Team		TOTAL(Z$)
		Number	VALUE(Z$)	Number	VALUE(Z$)	
Gokwe North	1990/91	89	547,100	9	145,220	692,320
Copper Queen	1991/92	52	362,505	3	23,365	385,870
	1992/93	42	248,516	1	8,200	256,716
	1993/94	42	315,315	—	—	315,315
	1994/95	52	424,885	1	10,000	434,885
Gokwe North	1990/91	42	31,941	—	—	31,941
Nyaurunbwe	1991/92	4	4,284	—	—	4,284
	1992/93	80	78,803	—	—	78,803
	1993/94	8	11,290	—	—	11,290
	1994/95	29	46,825	—	—	46,825
Gokwe North	1990/91	863	627,039	37	36,807	663,846
Makore I & II	1991/92	787	752,881	44	41,958	794,839
	1992/93	294	328,773	—	—	328,773
	1993/94	173	324,589	—	—	324,589
	1994/95	31	55,803	2	3,030	58,833
Gokwe South	1990/91	386	716,616	42	42,065	758,681
Chesina I & II	1991/92	99	85,984	51	47,952	133,936
	1992/93	194	262,948	—	—	262,948
	1993/94	198	370,959	4	10,102	381,061
	1994/95	19	76,039	1	2,250	78,289
Kwekwe	1990/91	61	43,154	2	994	44,148
Mabara	1991/92	44	43,046	11	8,205	51,251
	1992/93	19	14,304	—	—	14,304
	1994/95	79	208,449	2	4,166	212,615
Kwekwe	1990/91	31	18,245	—	—	18,245
Sidakeni	1991/92	20	19,089	4	3,260	22,349
	1992/93	7	11,304	—	—	11,304
	1993/94	1	1,600	—	—	1,600
	1994/95	—	—	—	—	—

Table 4-3 Number and Value of Loans Granted by AFC by Type of Land Use 1982-1995

Year	LARGE SCALE COMMERCIAL		SMALL SCALE COMMERCIAL		RESETTLEMENT		COMMUNAL		COOP&COOP UNIONS		GRAND TOTALS	
	Number Granted	Value (z $ m)	Number Granted	Value (z $ m)	Number Granted	Value (z $ m)	Number Granted	Value (z $ m)	Number Granted	Value (z $ m)	Number Granted	Value (z $ m)
1982	2,103	88.80	3,649	4.60	911	0.50	30,150	10.10	—	—	36,813	104.00
1983	1,645	88.70	2,953	4.50	4,154	1.50	38,912	13.20	—	—	47,664	107.90
1984	1,400	110.20	3,052	8.10	19,874	10.60	50,036	23.40	—	—	74,362	152.30
1985	1,484	110.30	2,744	8.70	19,926	10.70	65,793	32.00	—	—	89,947	161.70
1986	1,308	113.00	2,569	11.50	13,866	8.50	77,526	38.90	—	—	95,269	171.90
1987	1,007	94.90	1,910	9.60	11,800	8.60	77,384	60.00	—	—	92,101	173.10
1988	990	111.20	1,542	9.00	11,217	9.00	69,885	49.40	—	—	93,634	176.40
1989	900	117.40	1,140	5.90	7,022	5.90	57,679	41.30	—	—	66,741	169.90
1990	969	136.30	844	5.90	5,193	5.90	43,846	33.40	—	—	50,852	180.10
1991	1,133	195.10	761	4.70	4,658	4.70	30,190	26.40	—	—	36,742	229.80
1992	1,499	358.24	727	10.52	6,307	10.52	27,344	29.73	—	—	35,877	405.27
1993	1,340	248.59	376	13.73	4,624	13.73	15,973	34.04	6	1.17	22,319	305.13
1994	808	308.63	379	18.39	3,706	18.39	13,755	54.95	4	0.80	18,652	392.42
1995	665	311.28	216	14.10	2,036	14.10	5,463	43.37	2	0.79	8,382	381.56

Table 4-4 Fertilizer Salesby Subsector, 1974/75-1989/90

Year	Total Sales	Large Commercial		Export Garden		Small commercial		Communal		Resettlement	
	million ton	million ton	(%)	million ton	(%)	million ton	(%)	million ton	(%)	million ton	(%)
1974/75	449.000	425.000	95	—	—	—	—	—	—	—	—
1975/76	334.000	315.000	94	—	—	—	—	—	—	—	—
1976/77	362.000	342.000	94	—	—	—	—	—	—	—	—
1977/78	384.000	359.000	93	—	—	—	—	—	—	—	—
1978/79	357.000	332.000	93	—	—	—	—	—	—	—	—
1979/80	355.000	328.000	92	—	—	—	—	—	—	—	—
1980/81	470.625	396.412	82	—	—	—	—	—	—	—	—
1981/82	510.996	435.574	85	—	—	—	—	—	—	—	—
1982/83	456.996	364.640	80	—	—	—	—	—	—	—	—
1983/84	455.135	356.601	78	—	—	—	—	—	—	—	—
1984/85	396.951	274.329	69	—	—	—	—	—	—	—	—
1985/86	506.397	382.379	76	—	—	—	—	—	—	—	—
1986/87	462.051	338.051	73	—	—	11.870	3	79.740	17	32.560	7
1987/88	429.854	311.170	72	7.400	2	11.740	3	75.380	18	24.150	6
1988/89	474.484	349.300	74	15.400	3	13.850	3	72.800	15	23.150	5
1989/90	472.955	348.043	74	13.965	3	12.826	3	76.191	16	21.930	5

Table 4-5 Development Scenario

Scenario Code	A	B-1	B-2
Alt.-1: Kudu Dam	With	Without	Without
Alt.-2: Other Water Source	—	With	Without
Development Purpose	Agricultural & Rural Development thru Wide Area Irrigated Agriculture	Agricultural & Rural Development thru Spot Irrigated Agriculture	Agricultural & Rural Development without Irrigation
Development Term	Long	Middle	Short
Development Component	- Irrigation Facilities Construction according to Available Water Source in Kudu Dam - Agricultural Extension, Marketing, Agricultural Credit - Rural Infrastructure	- Water Source Development (Diversion Work Pond, Small/Medium Scale Dam) in Tributaries and Irrigation Facilities Construction - Agricultural Extension, Marketing, Agricultural Credit - Rural Infrastructure	- Agricultural Extension, Marketing, Agricultural Credit - Rural Infrastructure

Table 4-6 Projection of Population and Total Household/Farm Household

District	Ward	1992				2010		
		Population	No. of H.H	H.H. Size	No. Farms	Population	No. of H.H	No. Farms
Kadoma	S.C-20	2,872	517	5.56	491	4,401	792	752
	S.C-21	2,368	408	5.80	388	3,629	625	594
	S.C-22	3,916	673	5.82	639	6,001	1,031	979
	S.C-23	6,774	1,078	6.28	1,024	10,381	1,652	1,569
	S.C-24	6,823	1,115	6.12	1,059	10,456	1,709	1,624
	Sub-total	22,753	3,791	6.00	3,601	34,869	5,809	5,518
	Res(Muzve)	9,681	1,437	6.74	1,365	14,836	2,202	2,092
	Res(Sachu)	4,763	815	5.84	774	7,299	1,249	1,187
	S.S.C.F.	2,512	370	6.79	370	3,850	567	567
	L.S.C.F.	6,091	1,510	4.03	1,510	9,334	2,314	2,314
	Total	45,800	7,923	5.78	7,621	70,188	12,141	11,678
Gokwe N.	Makore-1	9,159	1,431	6.40	1,359	15,136	2,365	2,247
	Makore-2	6,148	1,027	5.99	976	10,160	1,697	1,612
	Sub-total	15,307	2,458	6.23	2,335	25,296	4,062	3,859
	Res(Nyaru)	1,039	172	6.04	163	1,717	284	270
	S.S.C.F.	6,516	867	7.52	867	10,768	1,433	1,433
	Total	22,862	3,497	6.54	3,366	37,781	5,779	5,562
Gokwe S.	Chisina-1	14,380	2,336	6.16	2,219	23,764	3,860	3,667
	Chisina-2	11,155	1,807	6.17	1,717	18,434	2,986	2,837
	Total	25,535	4,143	6.16	3,936	42,198	6,846	6,504
Kwekwe	Mabura	5,542	944	5.87	897	8,674	1,477	1,403
	Sidakeni	5,529	1,106	5.00	1,051	8,654	1,731	1,644
	Total	11,071	2,050	5.40	1,948	17,328	3,208	3,047
Grand Total		105,268	17,613	5.98	16,870	167,495	27,974	26,791

Table 4-7 Development Impact in Communal and Resettlemnt Areas

Particular	Scenario A (Kudu Dam)	Scenario B-1 (Medium Dam)	Scenario B-2 (No Dam)
1. Present Condition			
1-1. No. of Farms	14,122	14,122	14,122
1-2. Land Use (ha)			
- Cultivated land (Rainfed)	81,940	81,940	81,940
- Grazing/forest	274,540	274,540	274,540
- Dense Forest	2,420	2,420	2,420
- Total	358,900	358,900	358,900
2. Future Condition (2000)			
2-1. No. of Farms (Rainfed)	17,361	17,361	17,361
2-2. Land Use (ha)			
- Cultivated land (Rainfed)	81,940	99,064	99,064
- Grazing/forest	274,540	257,416	257,416
3. Future Condition (2005)			
3-1. No. of Farms			
- Irrigated	160	331	-
- Rainfed	19,595	19,424	19,755
- Total	19,755	19,755	19,755
3-2. Land Use (ha)			
- Cultivated land			
+ Irrigated	160	331	-
+ Rainfed	81,780	104,555	106,556
+ Sub-total	81,940	104,886	106,556
- Grazing/forest	274,540	251,594	249,924
4. Future Condition (2010)			
4-1. No. of Farms			
- Irrigated	14,700*	331	-
- Rainfed	8,777	22,146	22,477
- Total	23,477*	22,477	22,477
4-2. Land Use (ha)			
- Cultivated land			
+ Irrigated	14,700	331	-
+ Rainfed	43,070	115,443	117,444
+ Sub-total	57,770	115,774	117,444
- Grazing/forest	298,710	240,706	239,036
- Dense forest	2,420	2,420	2,420
- Total	358,900	358,900	358,900
4-3. Change in Land Use (ha)			
- Cultivated land			
+ Irrigated	14,700	331	-
+ Rainfed	- 38,870	33,503	35,504
+ Total	- 24,170	33,834	35,504
- Grazing/forest	24,170	- 33,834	- 35,504

Note: * Including 1,000 farms to be replaced from the reservoir area.

Table 4-8 Further Issues to be Considered/Cleared in Each Scenario

Further Issues	Development Scenario		
	A	B-1	B-2
1. Realization of dam component from viewpoint of management, operation & maintenance	***	*	-
2. Establishment of new set-up for overall project planning/implementation/management	***	**	*
3. Financial examination on allocated farm size under irrigated condition	***	**	-
4. Financial examination on guideline for allocating farm land under rainfed condition	*	**	***
5. Reviewing role & activities of existing research institution for irrigated agriculture	***	**	-
6. Reviewing role & activities of existing research institution for rainfed agriculture	*	***	***
7. Farmers training and set-up of farmers' organization	***	**	*
8. Due attention on people to be relocated from reservoir area	***	*	-
9. Measures to create farm economic surplus especially under rainfed condition	*	***	***
10. Due attention on both economic and social approach for promotion of proposed project	***	**	*
11. Introduction of staged development approach	***	**	-
12. Preparation of countermeasures for water-born diseases including malaria	***	**	-
13. Preparation of detailed topo-map and hydrological data	***	**	-
14. Implementaion of feasibility study	***	**	*
15. Procurement of development fund	***	**	*

Note: *** Strongly considered. ** Fairly considered. * Slightly considered. - Not necessary

Table 4-9 RELATION BETWEEN PROJECT COMPONENT AND DEVELOPMENT SCENARIOS

Project Component	Detailed Contents	Degree of Concern			Proposed Plan/Project
		A	B-1	B-2	
1 Research and Extension on Regional Farming Technology					Establishment of Regional Farming Technology Center (RFTC)
1-1 Improv./Research on Rainfed Farming					
1-1-1 Drought resistible crops	Sorghum, millet, etc.	○	◎	◎	
1-1-2 Drought resistible variety	Applicable in N.R. III & IV	○	◎	◎	
1-1-3 Feed crop/trees & livestock dev.	Utilization of grazing land	○	◎	◎	
1-2 Research/Develop/Extension on Irrigated Farming					
1-1-1 Applicable crop/variety	Maize, cotton, vegetables, beans	◎	○	–	
1-1-2 On-farm irrigation method	Irrig. quantity/interval etc.	◎	○	–	
1-3 Marketing System for Farm Products	Collect/analyse marketing inform'n	◎	○	○	
2 Reinforcement of Agri. Extension					
2-1 Increase of Extension Workers	Mobilization of staff	◎	◎	◎	Budget allocation to ACRITEX
2-2 Provision of Facility/Equipment	For existing extension offices	◎	◎	◎	Audio Visual, Communication, Byke
2-3 Re-training of Extension Workers	Training relating to 3. & 4.	◎	◎	◎	Training at RFTC
2-4 Farmers' Training	Training on 1., 4. & 9-2	◎	◎	◎	Extension office and T.& V. system
3 Marketing System Development					
3-1 Access Road Development	Ring road, upgrading exit tracks	◎	◎	◎	Ring road: 35 km, upgrading: 350 km
3-2 Collection/Delivery of Farm Products	Construction of collection point	◎	◎	◎	Concrete floor, temp. shed, scale
3-3 Collective Purchase System	Multi-use of collection point	◎	◎	◎	Relating to Item 5
4 Activation of Farmers' Organization					Guiding/training farmers
4-1 Crop Production Group	Utilization of special favour	◎	◎	◎	
4-2 Livelihood Cooperative	Collective purchase system	◎	◎	◎	
4-3 Agricultural Cooperative	Step up relating to 3. & 5.	◎	◎	◎	
5 Farmers' Participation	Implement in relation with 4.	◎	◎	◎	Project explanation, etc.
6 Reinforcement of Agricultural Crediting System					
6-1 Public Subsidy to Crop Insurance	Grouping of farmser	◎	◎	◎	Farmers training, Budget allocation
6-2 Alleviated Condition of AFC Loan	Intensified subsidy to AFC	◎	◎	◎	Low rate two step loan to AFC
6-3 Activation of AFC Lending Program	- ditto -	◎	◎	◎	- ditto -
6-4 Establsih New AFC's Liaison Office	- ditto -	◎	◎	◎	Budget allocation to AFC
7 Rural Infrastructure Development					
7-1 Securing Drinking Water Yearround	Domestic/livestock water	◎	◎	◎	Rehabili. of exit. well and new well
7-2 Provision of Community Center	Reinforcement of collection point	◎	◎	◎	Meeting hall
8 Water Resource and Irrigation Development					
8-1 Medium Dam Project					
8-2-1 Construction of dams		○	◎	–	8 dams
8-2-2 Main/on-farm irrigation facilities		○	◎	–	About 330 ha
8-2 Kudu Dam Project					
8-2-1 Construction of Kudu dam		◎	–	–	Total capacity: 1,500 MCM
8-2-2 Main irrigation system		◎	–	–	Main & secondary canals: 196 km
8-2-3 On-farm facilities	Levelling/relocation of cult. land	◎	–	–	About 25,000 ha
8-2-4 Construct. of new rural community	Around secondary canals	◎	–	–	
8-2-5 Relocation of people in reservoir	To be relocated to irrigated area	◎	–	–	About 1,000 households
9 Conversion of Existing Land Use					
9-1 Grazing/Bush Land to Cultivated Land	Allocation to increased farmers	–	◎	◎	Reclamation works
9-2 Cultivated Land to Grazing Land	Feed crops/trees, pasture	◎	–	–	Livestock development
9-3 Soil Conservation	Contour bund, reforestation	○	◎	◎	
10 Management, O & M of Project Facility					
10-1 Main/Trunk Facilities	Cooperation of DWD, ACRITEX, Local	◎	○	–	Establishment of new implm'g agency
10-2 On-farm Facilities	Water users'group, etc	◎	○	–	Guiding/training farmers

◎ Strongly concerned, ○ Fairly concerned, – Not concerned

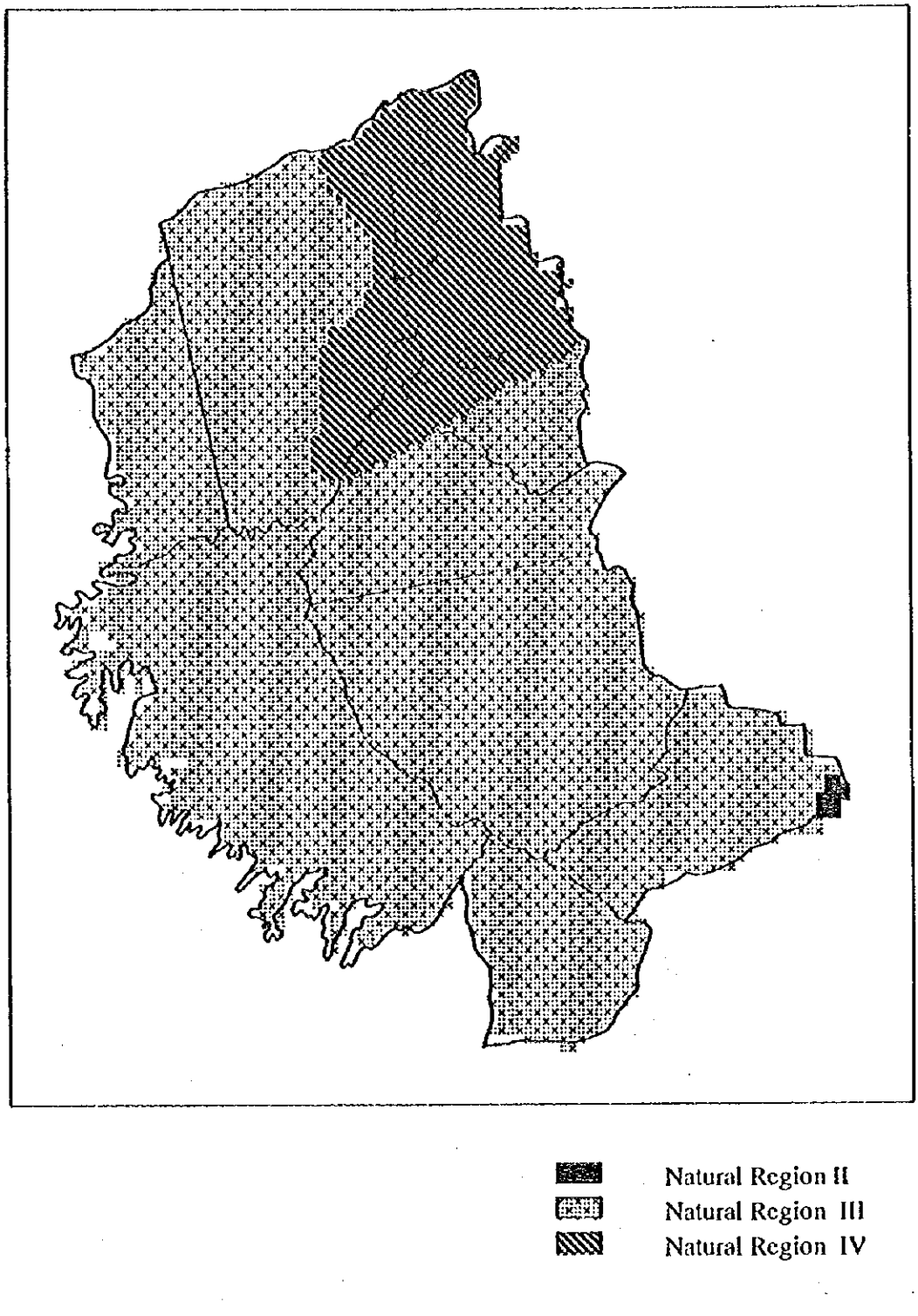


Figure 4-1 NATURAL REGION MAP OF THE STUDY AREA

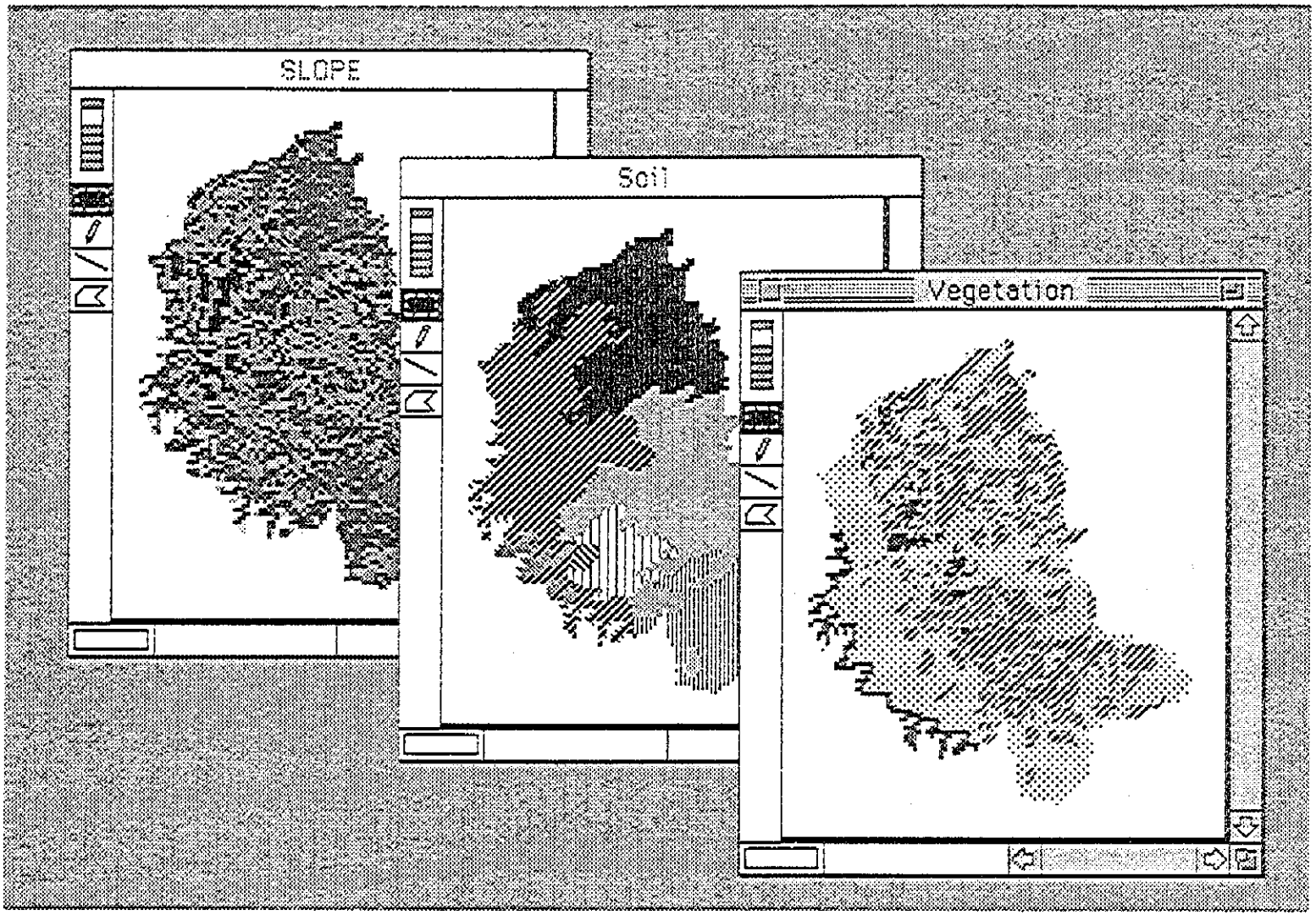


Figure 4-2 EVALUATION OF SOIL EROSION HAZARD OF THE AREA BY MAP OVERLAY METHOD

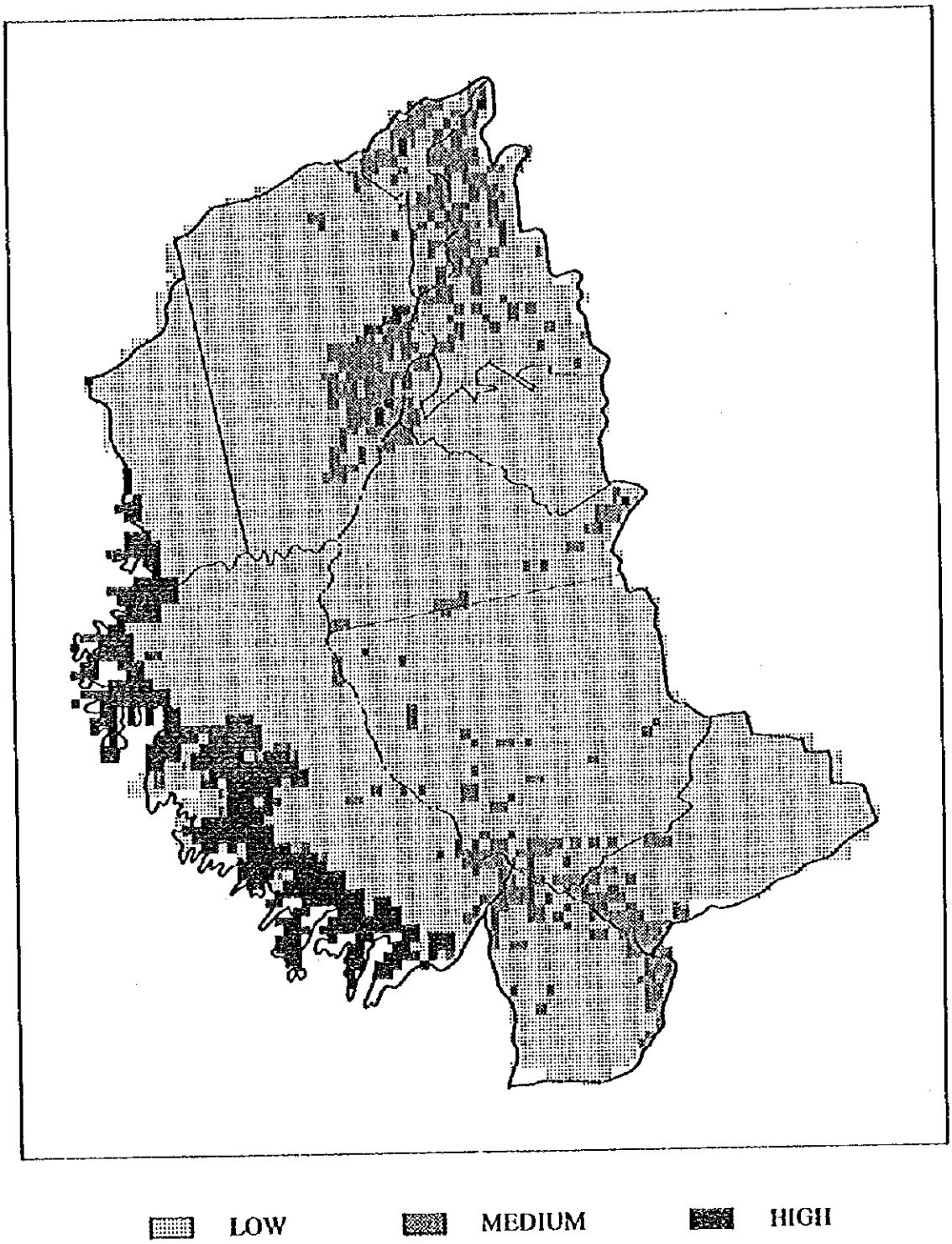


Figure 4-3 SOIL EROSION HAZARD RATING OF THE STUDY AREA

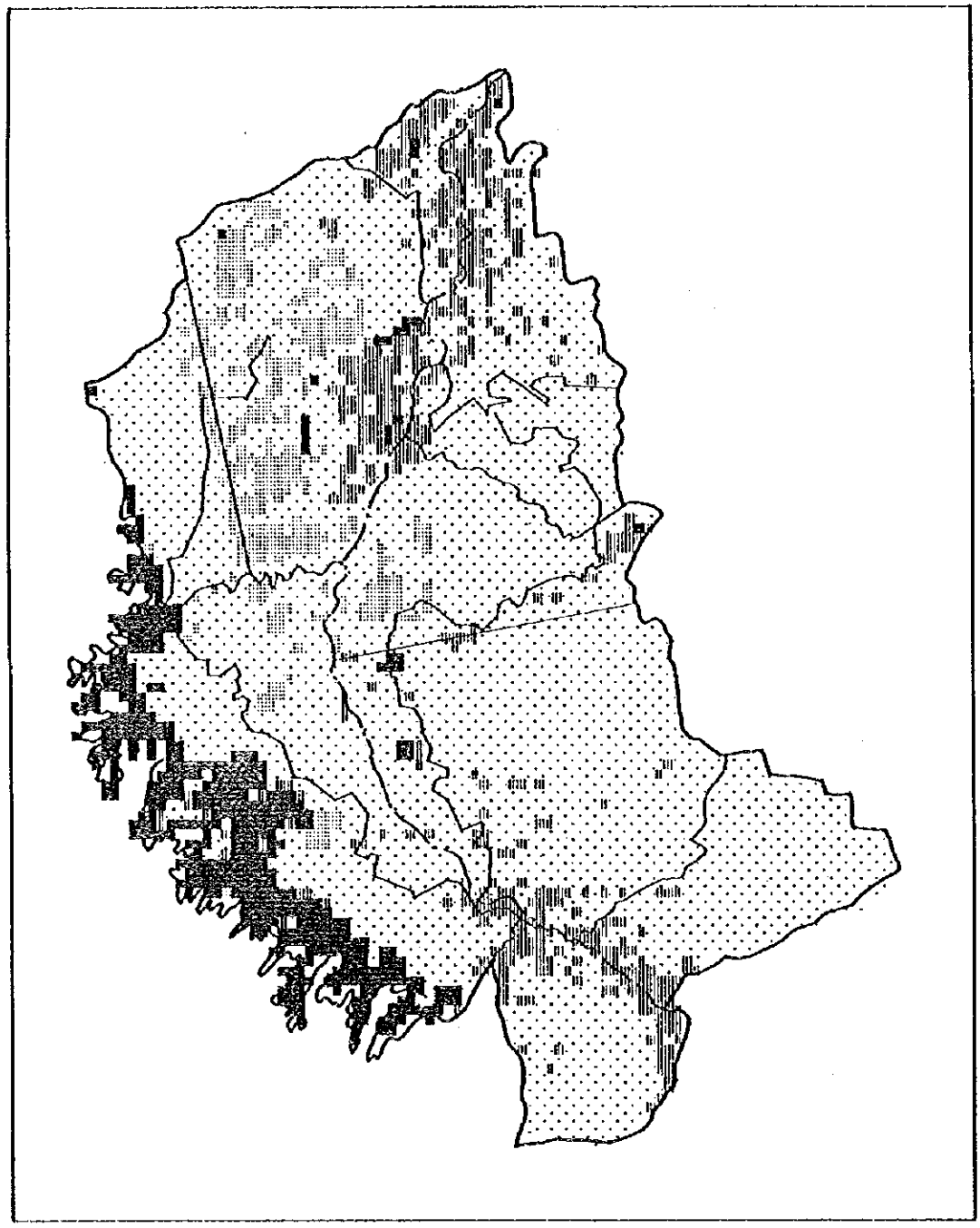
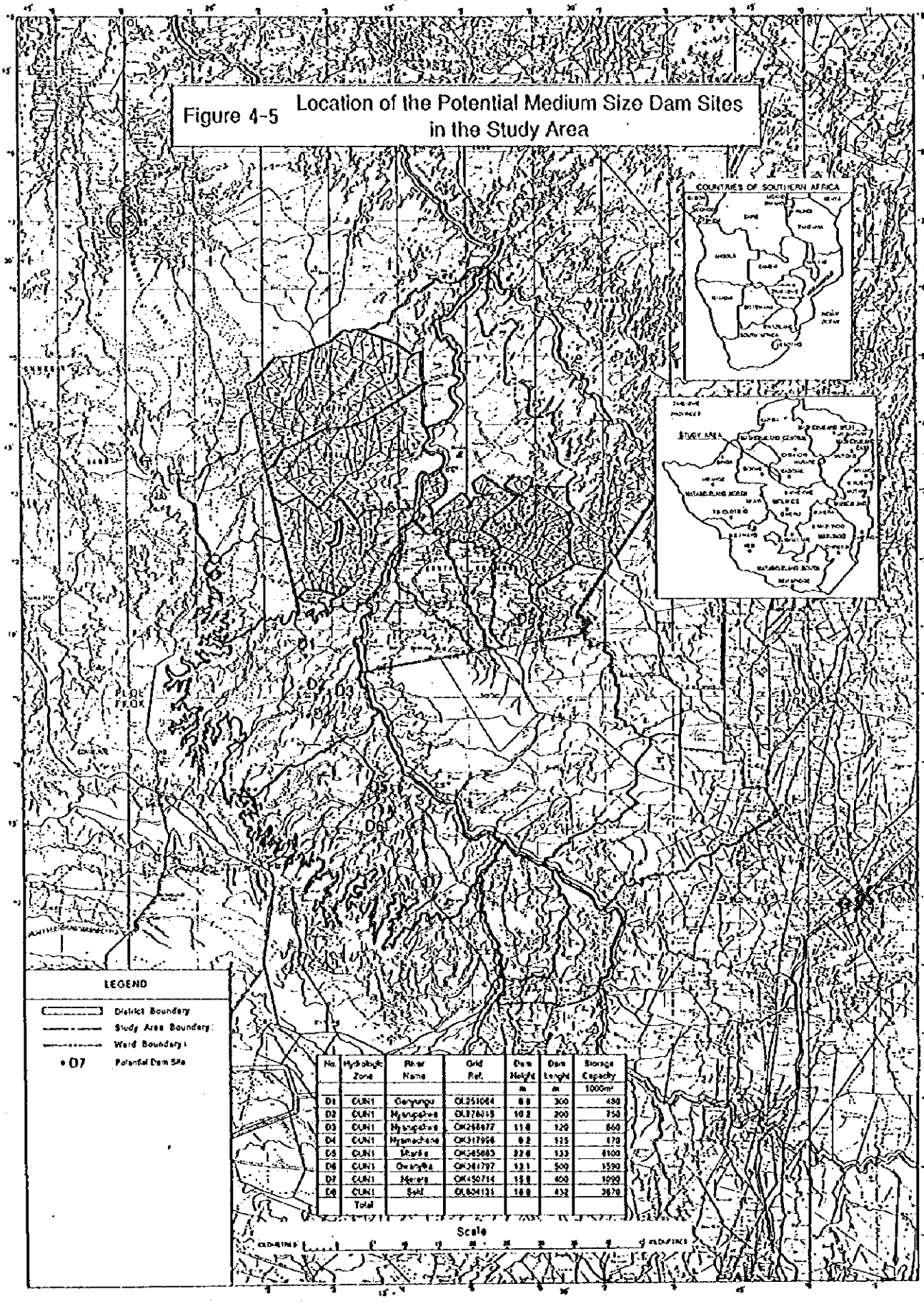


Figure 4-4 LAND RESTRICTION FOR IRRIGATION OF THE STUDY AREA

Figure 4-5 Location of the Potential Medium Size Dam Sites in the Study Area



No.	Hydrologic Zone	River Name	Grid Ref.	Dam Height m	Dam Length m	Storage Capacity 1000m³
D1	CUN1	Gonyungo	OL251004	8.0	300	480
D2	CUN1	Nyangabwe	OL276015	10.2	200	750
D3	CUN1	Nyangabwe	OK288977	11.0	120	860
D4	CUN1	Nyamachana	OK317956	8.2	125	670
D5	CUN1	Mwaka	OK345883	22.0	133	8100
D6	CUN1	Gwenyika	OK381797	12.1	500	1590
D7	CUN1	Nenere	OK450714	15.8	400	1990
D8	CUN1	Sebi	OL604135	16.0	432	3670
	Total					

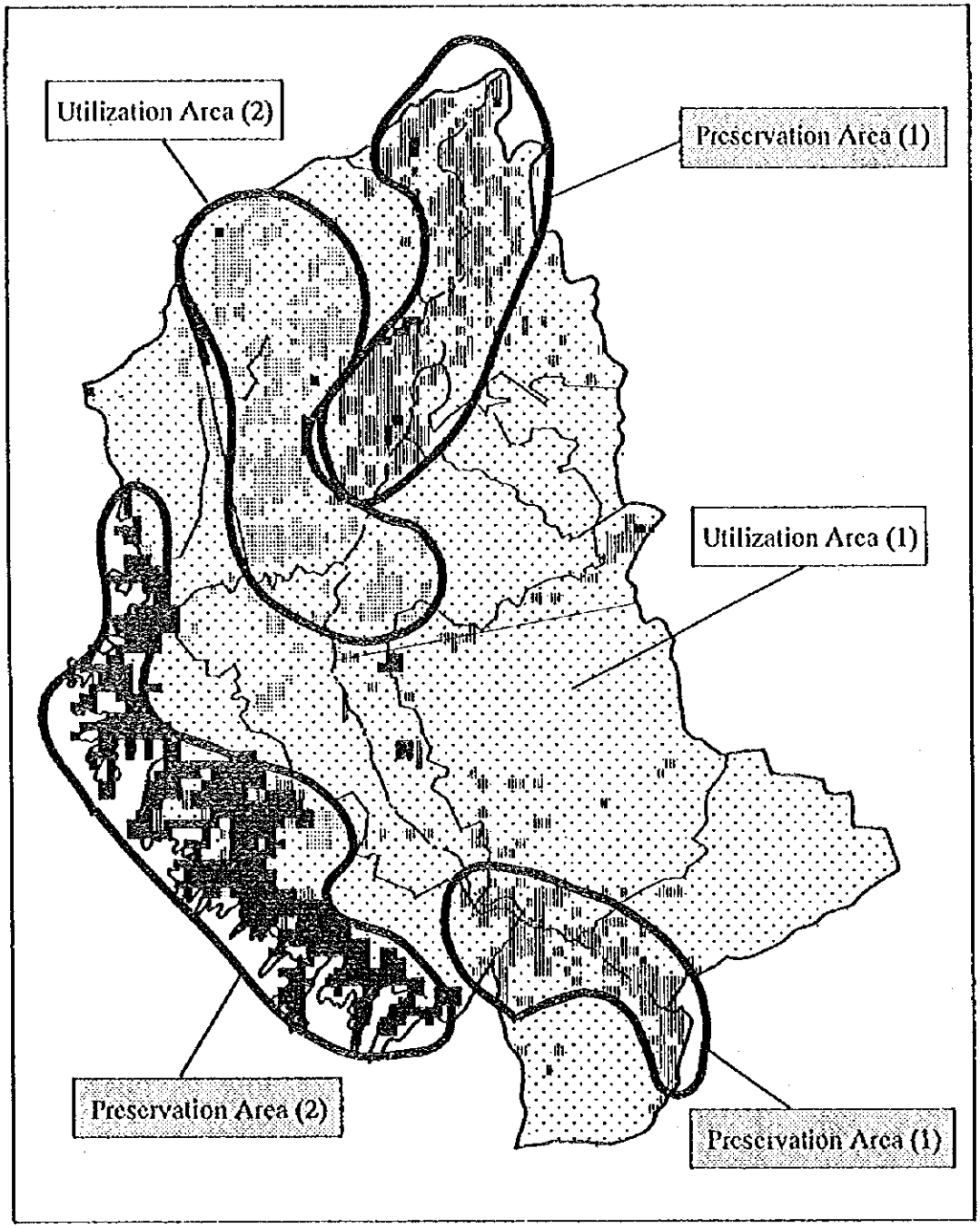
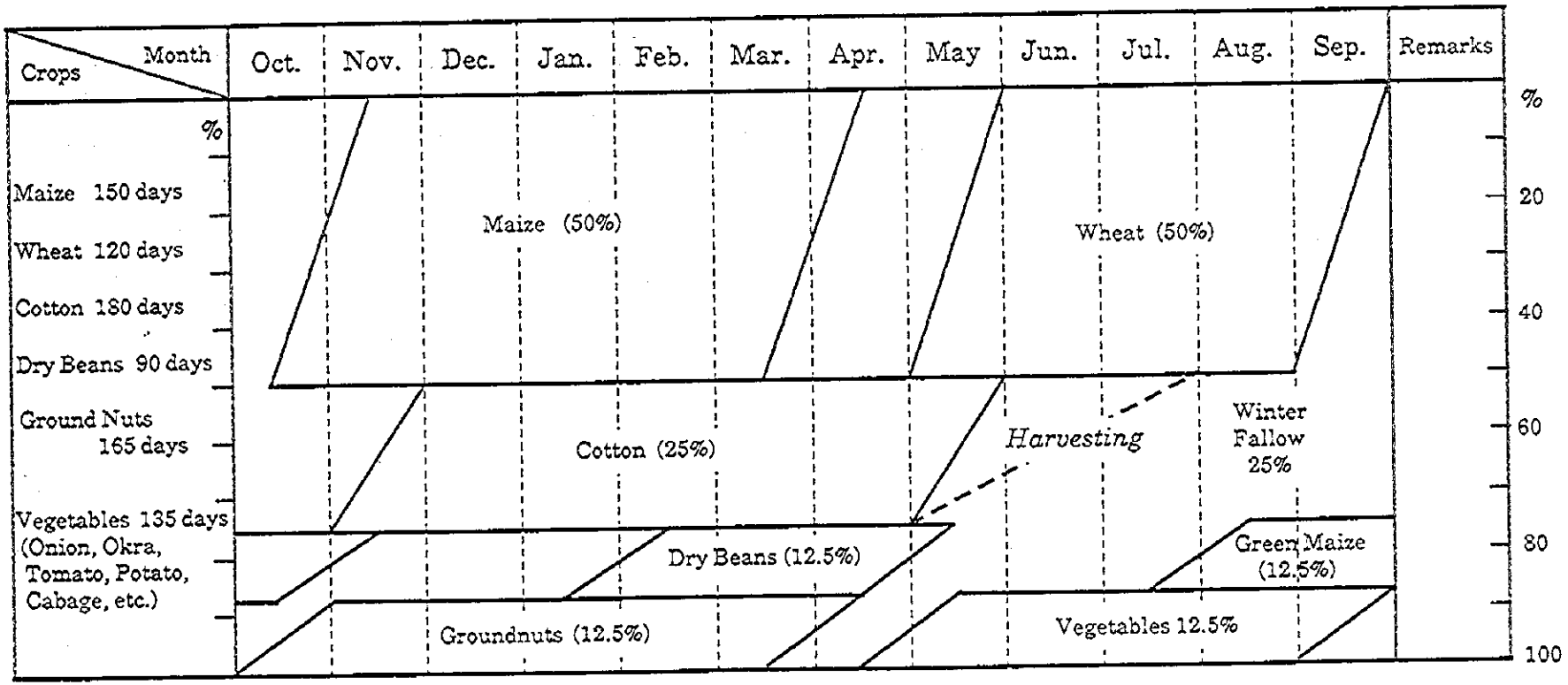


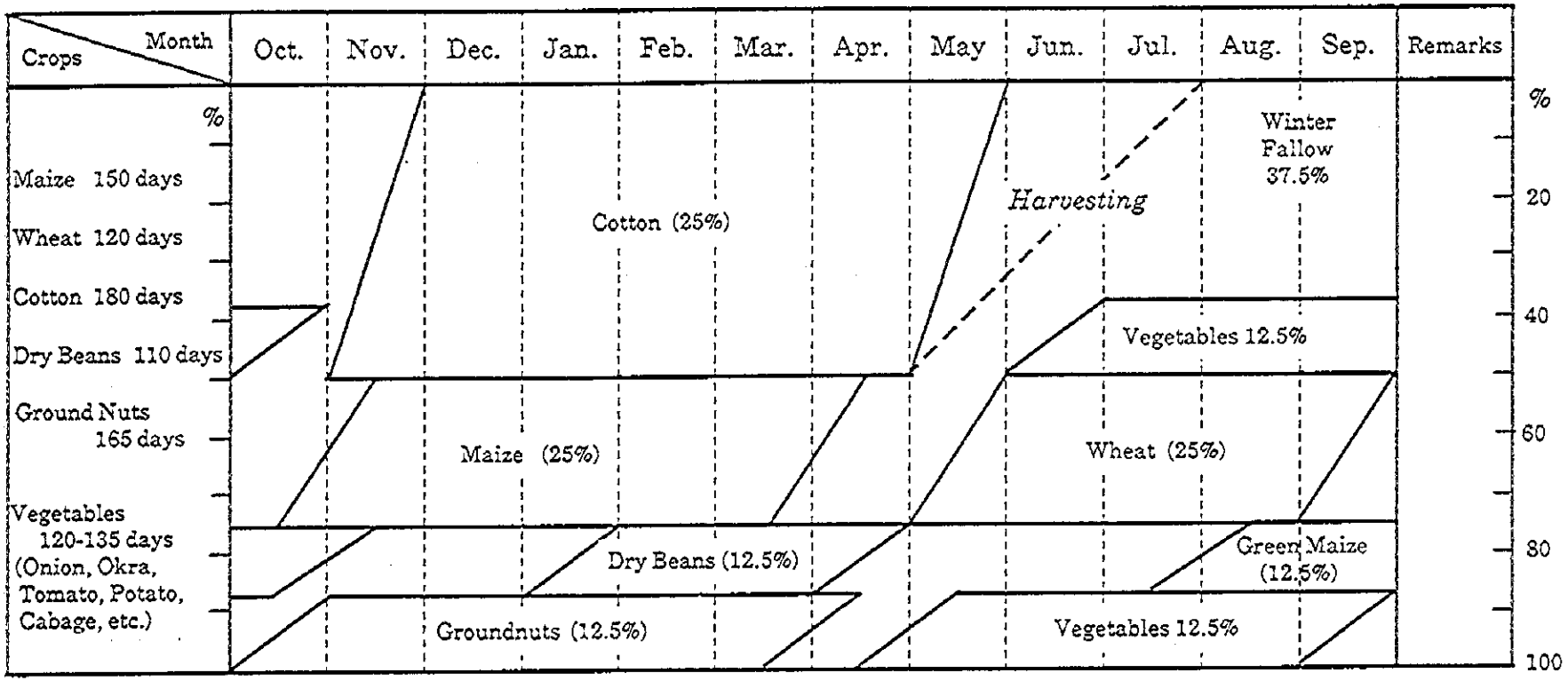
Figure 4-6 MAPPING FOR LAND DEVELOPMENT OF THE STUDY AREA

Figure4-7 PROPOSED CROPPING PATTERN No.1
(MAIN CROP ; MAIZE)



Note : Proportion of the Cropped Area in Winter Season shall be decided by Kudu Dam Reservoir Operation.

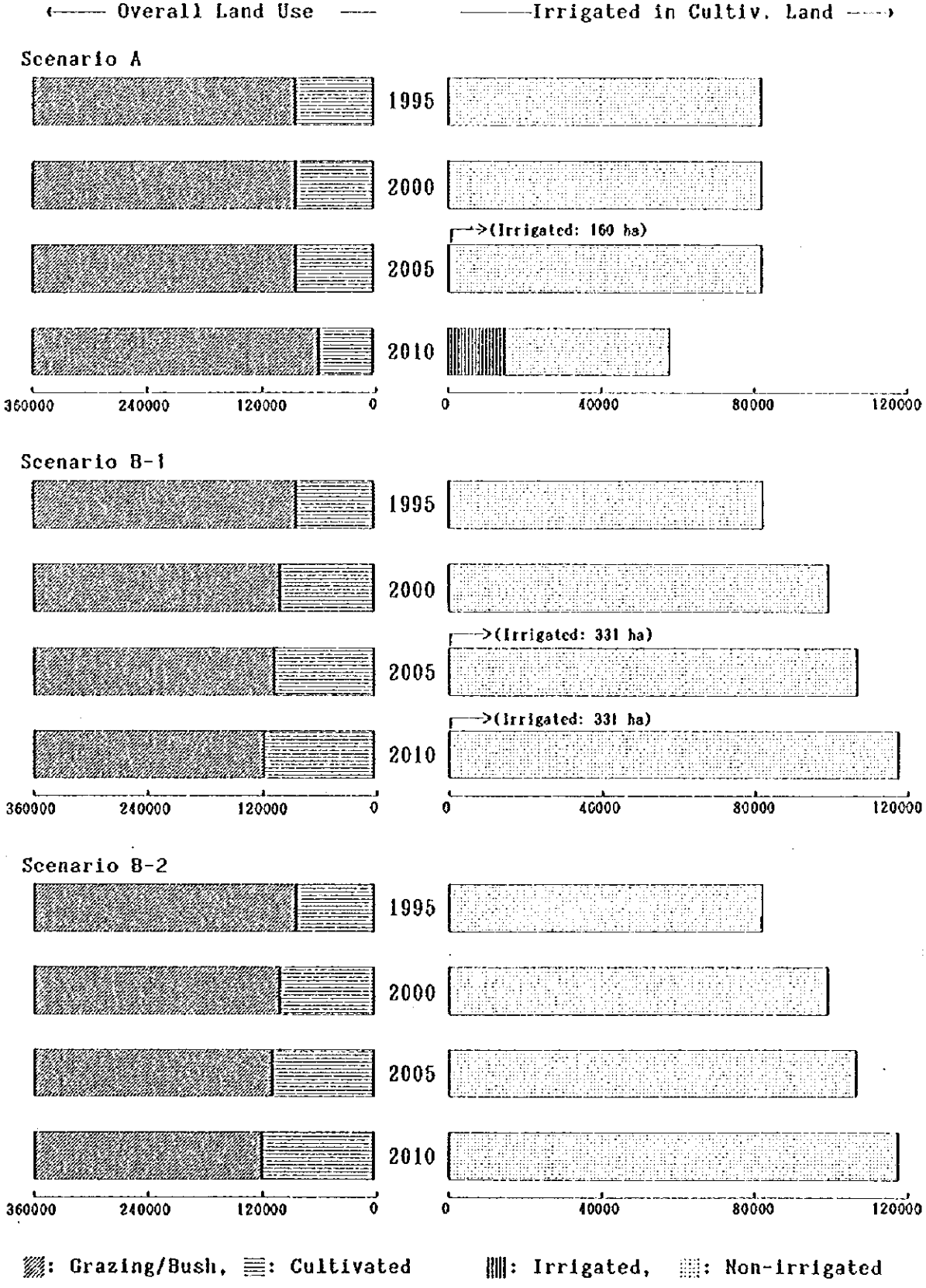
Figure 4-8 PROPOSED CROPPING PATTERN No.2
(MAIN CROP ; COTTON)



Note : Proportion of the Cropped Area in Winter Season shall be decided by Kudu Dam Reservoir Operation.

Figure 4-9

DEVLOPMENT IMPACT: CHANGE IN LAND USE OF COMMUNAL/RESETTLEMENT (ha)



CHAPTER 5

BASIC AGRICULTURAL DEVELOPMENT PLAN

CHAPTER 5 BASIC AGRICULTURAL DEVELOPMENT PLAN

While in "4.5.2 Development Framework" of Chapter 4, description is being made in order of Scenario A, B-1 and B-2, on the basis of size and scope of project component covered by each scenario, description order is opposite in this Chapter 5, taking into consideration that Scenario B-2 is the first option, then Scenario B-1 and A when considering staged development.

5.1 Scenario B-2

5.1.1 Land Use Plan

Under Scenario B-2, any irrigation facilities will not be introduced. Therefore, most of the cultivable land of the Study Area will remain non-irrigated, and traditional rainfed farming will be practiced dominantly. Some part of the grazing land will be converted to rainfed farming land along with the population increase in the area. Under the semi-arid conditions, which prevail in the area, rainfall is limited and often erratic. Both farming and grazing lands in the area are very prone to deteriorate by soil erosion and frequent drought, and effective control measures are required. The prevention of soil erosion, efficient grazing control and fodder conservation contribute considerably to support farmers' economy especially in times of drought. To improve the crop yield, introduction of drought resistant field crops or varieties is important. In addition, establishment of drought resistant fodder crops is also very important factor that should be duly regarded. In this context, introduction and enhancement of sylvo-pastoral system, which is one of the agroforestry systems, will be effective to improve the grazing lands and to stabilize the farmers' income in the area under Scenario B-2.

The sylvo-pastoral system is the combination of woody plants production with pasture, fodder crops or rangeland. The trees and shrubs may be used primarily to produce fodder for livestock or they may be grown for timber, fuelwood, fruit, or to improve the soil. There is a clear need for the sylvo-pastoral system in dry savanna zones, particularly to help meet wood and fodder demands throughout the year and to maintain

fodder reserves through dry periods. The system can also help to maintain the stability and fertility of grazing lands and to reverse the tendency toward land degradation and desertification.

5.1.2 Proposed Cropping Pattern and Farming Plan

In this scenario, it is not planned to develop any water resource for irrigation purpose, and the rainfed area of about 117,000 ha will be continued, therefore, the present cropping pattern will unchange. On the other hand, crop yield of maize and cotton as major crop and sunflower and groundnut will be improved (20 - 65%) due to efforts on research, experiment and extension on rainfed farming technology applicable to Natural Region III. Table 5-1 shows target yield of various crops.

Under the scenario, 50 percent, 40 percent and each 5 percent of about 82,000 ha are cropped with maize, cotton, and sunflower and groundnut, respectively, in the existing 14,000 farms that could attain the target yields under rainfed but without drought damage as shown in Table 5-1. And, about 8,400 new farms with a total acreage of 35,000 ha will be able to attain the same crop yield level and cropping pattern as the present farmers do.

5.1.3 Water Resource Development and Utilization Plan

(1) Surface water

Annual discharge of Munyati river is quite unstable, and existing water rights have been fixed by mining companies, railroad, commercial farms and government. In order to newly exploit water resource in this scenario, surplus water should be created by integration and abolition of the existing intakes along the river and by proper management of the water control. But due to the decrease tendency of the recent river flow and many existing water rights, it is rather difficult to develop additional water resource without considering any water use facility like a dam. Thus, the available water resource is estimated at 11.8 MCM including existing water rights amounting to 10.1 MCM, which is limited in the Study Area only, and the surplus water of the Ngondoma Dam to be used for a new irrigation scheme of additional 150 ha.

Water Source Facility	Available Water Volume
- Existing Water Rights (from Umsweswe & Munyati confluence to Umfuli)	9.6 MCM
- Ngondoma Dam (Existing Irrigation Scheme (44 ha))	0.5 MCM
Sub - total	10.1 MCM
- Ngondoma Dam (New Irrigation Scheme (150 ha))	1.7 MCM
Total	11.8 MCM

(2) Groundwater

According to the Plan of Operation for National Rural Water Supply and Sanitation Programme (NRWSSP), it aims to supply a population of 250 per one well (Refer to Table 5 - 2). Based on this standard, 43 new boreholes will be required, with total amount of necessary yield of at least 0.6 MCM/year. Judging from the production capacity per well (2.6 - 8.6 ㎥/hour), these wells should be solely used for drinking water of both human beings and animals.

5.1.4 Rural Infrastructure Development

(1) Improvement of road network

In the scenario where rainfed farming will be still dominant, the following rural infrastructure development is proposed for the purpose to uplift living standard of dwellers and to provide an impact for increasing economic surplus of smallholder farmers.

- Existing tracks of 279 km which connect villages with main and secondary roads will be upgraded to gravel roads of 3 m width;
- 35 km of gravel road with 3 m width will be newly constructed from Chenjiri camp to conjunction point of Munyati and Mufri rivers;
- A part of ring road of 70 km connecting Sanyati, Copper Queen and Gokwe will be upgraded to asphalt road;
- New bridge over Munyati river between Umsweswe resettlement land and Chisina communal land will be constructed.

By these road improvement, local people could enjoy easier access to

local governmental and medical services and reduction of vehicle operating cost.

(2) Drinking water

As stated in item "5.1.3 (2) Groundwater", Zimbabwean governmental policy plans to supply water for 250 persons per well in the communal and resettlement lands. In accordance with the standard, 43 new wells will be required (See Table 5-2). In addition, based on the field investigation, 60 out of the existing 338 wells should be rehabilitated. In this connection, it is planned to construct 43 new wells and to rehabilitate 60 existing wells (mainly a hand pumped well).

(3) Community Centre

It is proposed to construct a community centre in which local government can positively approach to local people, and farmers training will be provided, in such six Wards of Sidakeni, Umsweswe, Chisina I & II, and Sanyati.

5.1.5 Farmers Supporting Services

(1) Research and extension on regional farming technology

In this scenario, an agricultural development will be promoted on the basis of the present rainfed farming, and it is a very important point on how to alleviate drought damage under rainfed conditions. In this regard, it is necessary to carry out research, experiment and extension on drought resistant crops and variety presently grown in the area. In addition, it is also required to develop superior species of animals and to experiment on a more effective utilization of the grazing land. This is because animal husbandry is playing a vital role together with crop cultivation in the area.

(2) Reinforcement of agricultural extension

At present, the farming level of smallholder farmers in the communal and resettlement areas remains low, and hence it is a very important

factor for the successful implementation and management of the project to strengthen agricultural extension activities for these farmers. Therefore, AGRITEX should make an effort to secure a necessary budget for retraining its extension staff as well as farmers. These farmers could be trained in the AGRITEX district offices. Guiding and training AGRITEX's extension staff on improved farming technology in semi-arid areas, is one of key roles.

(3) Activation of farmers organization

According to the field survey, there might exist such farmers organizations perfunctorily as a crop production group and a livelihood cooperative, but these organizations are presently of dormant due to lack of solidarity in rural communities. In order to activate such organizations, a Ward level crop production group (mainly maize and cotton) and livestock production group (mainly beef cattle) should be organized, through which members are able to enjoy privilege of tax exemption for input materials and aiming to increase bargaining power by collective marketing and purchasing. In future, these production groups will be gradually united towards establishment of an agricultural cooperative, which could give its strong effect in scopes of marketing and crediting. In the unification activities, it is necessary to guide and train AGRITEX extension staffs and then farmers.

With respect to establishing agricultural cooperatives, it is necessary firstly to find out capable persons as a leader in each Ward, secondly to educate and train them, and thirdly let them to exhibit their leadership in the groups. On the other hand, it is another way that available resources should be intensively concentrated in several selected Wards, as a model, in which people would learn necessity and procedure of re-unification and reinforcement of their organization, and such activity will be gradually expanded to other Wards.

(4) Strengthening of agricultural credit

Especially, the smallholder farmers in the communal and resettlement areas have very limited access to the prevailing agricultural crediting system, and it is quite difficult for those farmers to escape any drought

damage under the rainfed condition without a certain financial assistance. In this connection, in order to improve accessibility to the current crediting system by smallholder farmers, (a) introduction of crop insurance system, (b) to soften conditions in AFC's group lending scheme, and (c) reinforcement of subsidy to AFC for the purpose to use AFC's tie-up schemes, are to be required. When the Zimbabwean government would face any difficulty to bear the required cost for the said countermeasures, a certain effort should be made to introduce so-called two-step loan from external sources. Because the interest rate applicable to the two-step loan is usually well below the AFC's interest rate to farmers, by which AFC will be able to secure the required fund. In addition, in order to improve the accessibility from smallholder farmers, establishment of new AFC liaison offices and introduction of depositing operation in AFC should be taken into consideration in future.

5.1.6 Marketing Plan

(1) Road network development

It could be expected that transportation cost for farm products and farm input will be reduced by using the road network improvement planned in the rural infrastructure development in the item "5.1.3 (1) Road Network Development". In addition, through establishment of collection points for farm products as mentioned below, it is expected opportunity of more small and medium transporter's participation will increase.

(2) Collection point

For the purpose of strengthening the existing marketing channel for maize and cotton, one depot in Gokwe and six collection points of COTTCO, as well as five collection points of GMB will be established (See Table 5-3). The structure of these collection points is simply designed with concreted floor and temporary shed, having a weighing scale. These collection points could be used as a temporary storage for purchased farm input.

5.1.7 Regional Farming Technology Centre (RFTC)

In order to research and experiment on improved rainfed farming technology, and to extend the results to farmers, it is proposed to establish "Regional Farming Technology Centre" in each side of Munyati river. In this centre, research and experiment shall be carried out on drought resistance crop and variety applicable to NR III and effective use of grazing land including sylvo-pastoral system. The centre also collect and analyse such information on farm products' marketing including internal and external movement of supply and demand. Furthermore, results obtained in the centre shall be transmitted to farmers in the area through guidance and training for AGRITEX extension staff. The facility plan for the RFTC is shown in Table 5-4.

5.1.8 Preliminary Cost Estimate

(1) Condition of cost estimate

The project cost is estimated under the following conditions and the same conditions are also applied to Scenario B-1 and A.

- These costs are estimated based on the current market prices in January, 1995 which was the completion time of the field investigation by the study team.
- The construction mode is on contract basis.
- Unit prices of building materials and civil works are based on the detail design reports prepared by AGRITEX and DWD.
- Estimation of the inflation rate is based on the "CONSUMER PRICE INDEX 1990=100" and "BUILDING MATERIALS PRICE INDEX, 1980=100".
- Engineering services cost is considered as 10 % of the base cost.
- The adopted exchange rates between Zimbabwean dollar and U.S. dollar or Japanese Yen are US$1.00=Z$8.3871 and Z$1.00= ¥12.687.
- The percentages for foreign and local currency portions are based on 75% and 25%, respectively.

(2) Project cost

The total project cost at current price is estimated at 378.7 million Zimbabwean Dollars and summary of the costs are shown below (Refer to Tables 5-5 and 5-6, and Appendix M).

(Unit: Z$ million)

Description	(At 2000)	(At 2010)
1) Development of the Infrastructure		
- Const. and Rehabil. of Road	53.4	53.4
- Const. of Collection/Deposit Point	8.0	8.0
- Const. and Rehabil. of Boreholes	1.7	1.7
- Construction of Community Centre	1.2	1.2
Sub-total	64.3	64.3
2) Land Reclamation and Soil Conservation	145.1	300.8
3) Regional Farming Technology Centre	13.6	13.6
Total	223.0	378.7

(3) Operation and maintenance cost

The annual operation and maintenance cost is composed of salary and wages for O & M organization staff, administration and general expenditures, fuel and oil cost, maintenance cost of the facilities and office equipment etc., and estimated at Z$ 8.4 Million.

5.2 Scenario B-1

5.2.1 Land Use Plan

The Scenario B-1 will introduce medium-size dams for irrigation. However, command area of these dams will be 331 ha in total, resulting in that most of the cultivable land will not be irrigated. Thus, similar to Scenario B-2, the introduction of drought resistant crops and varieties in the present farming as well as promotion of livestock development through sylvo-pastoral system will be very important components.

5.2.2 Proposed Cropping Pattern and Farming Plan

In this scenario, 331 ha will be irrigable by constructing eight medium-size dams. All the irrigable area will be located in the communal areas, and beneficial farmers will be 331. In this irrigable area, cropping pattern based on maize and cotton in rainy season and wheat and vegetables in dry season would be introduced as shown in Figure 4-7. In addition, every effort should be made in RFTC to develop irrigated farming technology so as to realize the target crop yield (Table 5-1) through training farmers by existing extension activities. In the rainfed area of about 115,000 ha, same farming as Scenario B-2 would be practised.

5.2.3 Water Resource Development and Utilization Plan

(1) Water resource development

Since there is no possibility to construct any diversion facility for gravity irrigation system in Munyati river itself, only medium-size dams in the tributaries are available in which about 4.3 MCM of water resource will be developed.

(2) Water utilization plan

The developed water of 4.3 MCM will firstly be used for irrigation of 331 ha, and then drinking water in schools and clinics nearby the dams. It is also expected that additional 150 ha will be irrigable in the Ngondoma Irrigation Scheme when surplus water become available by closure of Empress Mine.

5.2.4 Irrigation and Drainage Plan

(1) Design discharge

Irrigable area and design discharge in medium-size dams are ranging from 4 ha to 105 ha and 0.005 cu.m/sec to 0.131 cu.m/sec, as shown below:

NO.	River	Irrigable Area (ha)	Design Discharge (m^3/S)
D1	Ganyungu	18.0	0.023
D2	Narupakwe	11.0	0.014
D3	〃	4.0	0.005
D4	Nyamachene	8.0	0.010
D5	Mtanke	105.0	0.131
D6	Gwanyika	80.0	0.100
D7	Njerere	50.0	0.063
D8	Seki	55.0	0.069

(2) Irrigation method

In order to reduce cost burden for beneficial farmers through reduction of O & M cost, a gravity system and a furrow irrigation method on-farm would be applied. Main irrigation facilities are as follows:

- Water Source: Medium-size Dam
- Water Conveyance: Open Canal (Main Canal)
- Regulation: Farmpond
- On-Farm: Open Canal (Irrigation/Drainage) and Road

(3) Main canal

- The canal layout was determined by using a topographical map scaled 1:50,000.
- The concrete lining trapezoid canal that is familiar in Zimbabwe should be adopted taking into consideration the effective utilization of irrigation water and saving maintenance labour or cost.
- The canal slope should not exceed a slope of 1/300 considering the permissible flow velocity.
- The cross section of canal was determined on the basis of Manning's formula with roughness coefficient, n=0.015. Here, the minimum permissive velocity was adopted at 0.6m/s to prevent bilharzia.

(4) Night storage reservoir

- According to the farming program, the consumption of water fluctuates widely. Also, irrigation water should be supplied

constantly to the farm even under the conditions of repairing main/secondary canal because of some accidents.

- The capacity of reservoir is designed to be equal to peak field demand for 24 hours. And they should have one reservoir in a scheme.

- This reservoir was designed to be the pond enclosed with earth dikes, which is equipped with inlet, outlet, staff gauge, drain, bypass.

- The effective water depth is 2.0m and 0.5m depth as freeboard. And the top width is 2.0m, the external and internal slopes of embankment are 1:1.5.

(5) In-field facilities

1) Farmland block plan

- The size and shape of the standard farmland block were decided considering farm organization and farming system.

- The standard block was designed that its long side be 500m long and short side be 100m long.

2) Main & lateral road

- The road network consists of trunk roads and lateral roads.

- The trunk road should be connected to the existing road at almost right angle and the interval should be about 500m long. Also its width should be 4m, and the surface should be paved with gravel.

- The lateral road was planned to be bordered on the side of field block and connected to the trunk road at right angle. Also it should have intervals of about 100m long. The width should be 3m, and the surface should be paved with gravel.

3) In-field distribution canal

- The irrigation water is distributed to the individual plots by a network of reinforced precast concrete canal (trapezium shape).

- The delivery of water into each canal is controlled by an adjustable sliding gate attached at the regulator. And the supply of water to the plots is carried out through the plastic syphon tubes in front of the check plate.

4) Drainage canal

- It is supposed that the large scale drainage system is not necessary in the field-lots because upland farming is planned in the project area where the precipitation is not much.

- However, the minimum scale drain canals should be designed along the lateral roads on considering protecting the lands from severe erosion that are caused by unexpected intensive rain.

5.2.5 Rural Infrastructure Development Plan

In this scenario, rainfed agriculture will be playing important role similar with Scenario B-2, except 331 ha of irrigable area by medium-size dams. Therefore, the following rural infrastructure will be developed for the purpose to uplift farmers' living standard and to give impact on producing farm economic surplus:

(1) Road network development

Same as with Scenario B-2.

(2) Drinking water

Same as with Scenario B-2.

(3) Community centre

Same as with Scenario B-2.

5.2.6 Farmers Supporting Services

(1) Research and extension on regional farming technology

Irrigable area of this scenario is only 331 ha, and most of the area remains under rainfed condition. Therefore, same contents of Scenario B-2 would be deployed, i.e. research, experiment and extension of irrigated agriculture.

(2) Reinforcement of agricultural extension

The same contents of Scenario B-2 would be deployed, and it is necessary for AGRITEX to provide training for beneficial farmers on

irrigated farming technology with the collaboration of RFTC.

(3) Activation of farmers organization

The same contents of Scenario B-2 would be deployed. It is planned to establish a water user group in each medium-size dam. The composition and activity of the group should follow those of the existing Irrigation Management Committee. This water user group is composed of a chairman, a secretary and a treasurer, and several members democratically elected by member farmers. Its responsibilities are as follows:

- Operation of water distribution in the scheme;
- Maintenance of irrigation facilities;
- Collection of maintenance fees;
- Setting up of local rules and regulations; and
- Continuous training of irrigators

(4) Strengthening of agricultural credit: Same as with Scenario B-2

5.2.7 Marketing Plan

The same contents as with Scenario B-2 will be applied.

5.2.8 Regional Farming Technology Centre (RFTC)

In order to research and experiment on improved rainfed farming technology as well as irrigated farming technology, and to extend the results to farmers, it is proposed to establish "Regional Farming Technology Centre" on each side of Munyati river. In this centre, research and experiment shall be carried out irrigated agriculture (optimum cropping pattern, farming practices and water management) under the development of the medium-size dams. In addition, the same activities as with Scenario B-2 will be carried out. Furthermore, results obtained in the centre shall be transmitted to farmers in the area through guidance and training for AGRITEX extension staff. The facility plan for the RFTC is shown in Table 5-4.

5.2.9 Preliminary Cost Estimate

(1) Condition of cost estimate

The same conditions in Scenario B-2 are also applied.

(2) Project cost

The total project cost at current price is estimated at 474.8 million Z$ and details are shown below (Refer to Table 5-5 and 5-6, and Appendix M).

(Unit: Z$ million)

Description	(At 2005)	(At 2010)
1) Development of the Infrastructure		
- Const. and Rehabil. of Road	53.4	53.4
- Const. of Collection/Deposit Point	8.0	8.0
- Const. and Rehabil. of Boreholes	1.7	1.7
- Construction of Community Centre	1.2	1.2
Sub-total	64.3	64.3
2) Land Reclamation and Soil Conservation	193.5	286.6
3) Regional Farming Technology Centre	13.6	26.0
4) Construction of Medium-size Dams	89.4	89.4
5) Construction of Irrigation Facility	8.5	8.5
Total	381.7	474.8

(2) Operation and maintenance cost

The annual operation and maintenance cost is estimated at Z$ 10.4 Million.

5.3 Scenario A

5.3.1 Land Use Plan

According to the present land use data of the Study Area, total

acreage of the area is 505,200 ha, of which 101,140 ha (20.0%) is under cultivation including fallow in some areas. Planned irrigable area widely varies by the three different development scenarios. In Scenario B-2, irrigation development will not be introduced, and present cultivated land will remain under rainfed. In Scenario B-1, a total irrigable area of 331 ha is planned by constructing eight medium-size dams, and most of the present cultivated land will be under rainfed condition. In Scenario A ("With Kudu dam" conditions), it is planned to develop irrigation covering 25,000 ha.

Under Scenario A, 25,000 ha of irrigated land will be created. In case the present grazing land will be converted into irrigated area, some soil conservation measures will be needed. In addition, a large extent of the land will still remain non-irrigated. Therefore, especially in such non-irrigated land, the introduction of soil erosion control measures and drought resistant fodder crops will also be the important components, taking the sylvo-pastoral system into consideration.

5.3.2 Proposed Cropping Pattern and Farming Plan

For Kudu Dam, about 25,000 ha under 10 percent risk level will be irrigable. The area will be distributed to 14,700 ha for the communal and resettlement areas, 5,900 ha for S.S.C.F. and 4,400 ha for L.S.C.F. in accordance with AGRITEX guideline.

In the communal and resettlement land, a cropping pattern based on maize and cotton in rainy season and wheat and vegetables in dry season, will be introduced as mentioned in Figure 4-7. In addition, every effort should be made in RFTC to develop irrigated farming technology so as to realize the target crop yield (Table 5-1) through training farmers by existing extension activities.

On the other hand, sprinkler irrigation will be practised on the basis of cropping pattern of cotton in rainy season and vegetables in dry season as shown in Figure 4-8, in both commercial farm sectors.

Apart from these irrigated farmers, about 22,000 ha of existing 3,600 farms and 20,000 ha of new 5,100 farms remain rainfed, for which

same contents of Scenario B-2 will be practised.

5.3.3 Water Resource Development and Utilization Plan

(1) Water resource development

Based on water balance study for Kudu Dam, available water resources at 10 percent risk level is estimated at 380 MCM, which will be distributed irrigation, urban water supply and industrial purposes. On the other hand, Mtange and Sanyati-2 dams having higher economical and technical feasibility, will be utilized for RFTC's activities. Medium-size dams of Sanyati-2 and one planned in Mdzongwe river will be functioning as a regulating reservoir within the Kudu irrigation system.

(2) Water utilization plan

The developed water for Kudu Dam amounting to 320 MCM in 1/10 years probability, will be allocated for irrigation use and utilised on the basis of AGRITEX's guideline as follows:

Utilization	Amount (MCM)	Allocation (%)
Communal/Resettlment	188.2	58.8
S.S.C.F.	75.3	23.6
L.S.C.F.	56.5	17.6
Total	320.0	100.0

5.3.4 Irrigation and Drainage Plan

(1) Design discharge

Design discharges for planning irrigation facilities are shown in Figure 5-3. And these discharges were calculated based on the assumption that each canal should have enough capacity to convey the maximum water in 24 hours. Also, the maximum water discharge is required yearly from 16th to 20th in February.

(2) Main canal

- The canal layout was determined by using a topographical map scaled 1:50,000. The concrete lining canal should be adopted taking into consideration the effective utilization of irrigation water and saving maintenance labour or cost.

- The canal slope was planned at 1/6,000 based on the low water level of Kudu dam (EL.905m) and the ground levels at the canal tails.

- The cross section of canal was determined on the basis of Manning's formula with roughness coefficient, n=0.015. Here, the shape of cross section was adopted, a rectangular type, considering construction efficiency. And the minimum permissive velocity was adopted at 0.6m/sec to prevent bilharzia.

- If the canal must cross a depression such as river or stream, an inverted syphon should be used to convey the water. A steel pipe that is rolled up in concrete was adopted as the syphon form. This is from the viewpoint of safety.

- At the place where the canal meets low ground such as a gully, a pipe culvert across under the canal should be constructed to drain inundation nearby.

- The maintenance road should be constructed along the canal. Also these facilities should be protected by a fence.

(3) Regulating reservoir

- The regulating reservoir should be located on the middle point of canal for regulating the fluctuation of water demand and the delay of delivering water.

- Two regulating reservoirs were selected on each bank respectively from eight reservoirs which were components in Scenario B-1.

- The storage capacity is planned at a peak water demand of 24 hours.

- Dam type will be of a reservoir type and its structures are similar to those of Scenario B-1's.

(4) Night storage reservoir

- According to the farming program, the consumption of water fluctuates widely. Also, irrigation water should be supplied constantly to the farm even under the conditions of repairing main/secondary canals because of some accidents.

- The night storage reservoir should be built in the ratio of one reservoir to 100ha area of farm for buffering against fluctuation mentioned above.

- The capacity of reservoir is designed to be equal to peak field

demand for 24 hours, that is to say 10,800 cu.m.

- This reservoir was designed to be the pond enclosed with earth dikes, which is equipped with inlet, outlet, staff gauge, drain, bypass.

- The effective water depth is 2.0m and 0.5m depth as freeboard. And the top width is 2.0m, the external and internal slopes of embankment are 1:1.5.

(5) In-field facilities

1) Farmland block plan

- The size and shape of the standard farmland block were decided considering the farm organization and farming system.

- The standard block was designed that its long side is 500m long and short side is 100m long.

2) Main & lateral road

- The road network consists of trunk roads and lateral roads.

- The trunk road should be connected to the existing road at almost right angle and its interval should be about 500m long. Also its width should be 4m, and the surface should be paved with gravel.

- The lateral road was planned to be bordered on the side of field block and connected to the trunk road at the right angle. Also it should have intervals of about 100m long. The width should be 3m, and the surface should be paved with gravel.

3) In-field distribution canal

- The irrigation water is distributed to the individual plots by a network of reinforced precast concrete canal (trapezium shape).

- The delivery of water into each canal is controlled by an adjustable sliding gate attached at the regulator. And the supply of water to the plots is carried out through the plastic siphon tubes in front of the check plate.

4) Drainage canal

- It is supposed that the large scale drainage system is not necessary in the field-lots because upland farming is planned in the project area where the precipitation is not much.

- However, the minimum scale drain canals should be designed along the

lateral roads under considering about protecting the lands from severe erosion that are caused by unexpected intensive rain.

5.3.5 Rural Infrastructure Development Plan

In this scenario, a large irrigation system will be managed in 25,000 ha including 14,700 ha in the communal and resettlement areas. On the other hand, although its magnitude will decrease gradually, still about 42,000 ha remain rainfed. Therefore, the following rural infrastructure will be developed for the purpose to uplift farmers' living standard and to give impact on producing farm economic surplus:

(1) Road network

Same contents of Scenario B-2 are planned. In addition, maintenance road with total length of 296 km along main and secondary canals will greatly contribute for improvement of transportation network.

(2) Drinking water

Same as with Scenario B-2

(3) Community centre

Same as with Scenario B-2

5.3.6 Farmers Supporting Services

(1) Research and extension on regional farming technology

In this scenario, a large scale irrigation development will be introduced and promoted for the communal and resettlement areas, the small-scale commercial farms and the large-scale commercial farms by constructing the Kudu Dam. Especially, a large scale of 14,700 ha in the communal and resettlement land will be irrigated, and it is inevitable to research, experiment and extend an irrigated farming technology to the farmers. On the other hand, efforts to improve the rainfed farming technology should be continued, because still about 42,000 ha of rainfed land, a half of the existing cultivated land will remain.

(2) Reinforcement of extension services

Same contents of Scenario B-2 would be deployed, and it is necessary for AGRITEX to provide training for beneficial farmers on irrigated farming technology such as selection amd farming practice of appropriate crops, irrigation method and so on, with collaboration of RFTC. In addition, farmers in the irrigated area should be given necessary training on water management and O & M method of irrigation facilities.

(3) Activation of farmers organization

Same contents of Scenario B-2 would be deployed, it is necessary to establish a farmers organization in view of O & M of irrigation system commanded by the Kudu Dam. In this connection, a water user group in every farmpond (approx. 100 ha) is to be organized. The water management after farmpond will be carried out by the group with rotational irrigation method. Also, the group is responsible for operation and management of on-farm facilities and tertiary canals with assistance of AGRITEX. Composition and activity of the group are almost same as Scenario B-1, putting more emphasis on collection of water charges from beneficiaries. Furthermore, it is planned to establish water user's association in each secondary canal in order to efficiently execute the water allocation and management in wider range.

(4) Strengthening of agricultural credit

The same concept as with Scenario B-2 will be carried out.

5.3.7 Marketing Plan

The same as with scenario B-2 will be carried out.

5.3.8 Regional Farming Technology Centre (RFTC) and Model Project

(1) RFTC

In order to research and experiment on improved rainfed farming