Appendix 3 Land Use & Vegetation

Appendix 3

REPUBLIC OF ZAMBIA

LAND USE & VEGETATION

COMPILED BY AGRILANDS CONSULTANTS
02-05-1994

SCALE 1:1,800,000

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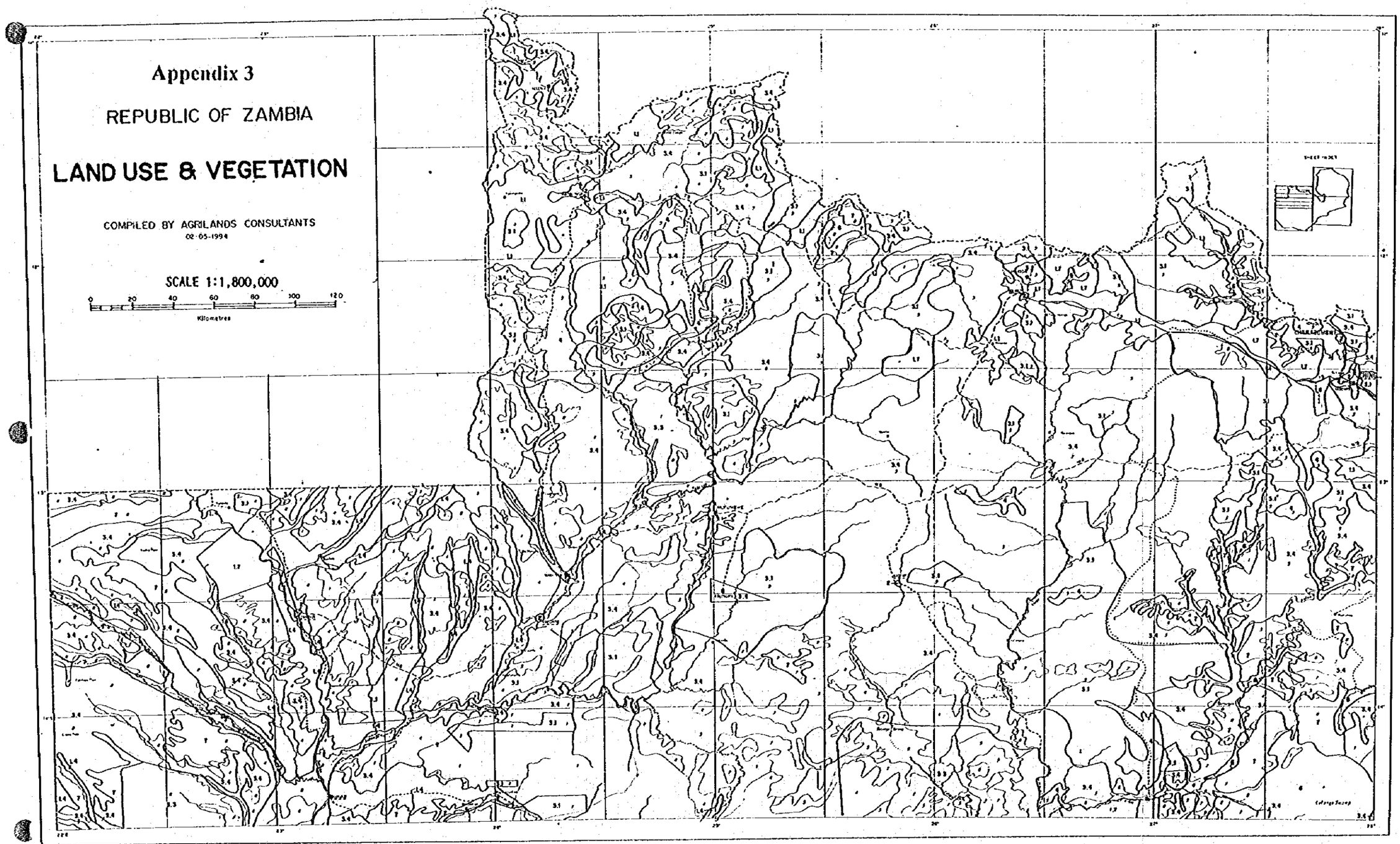
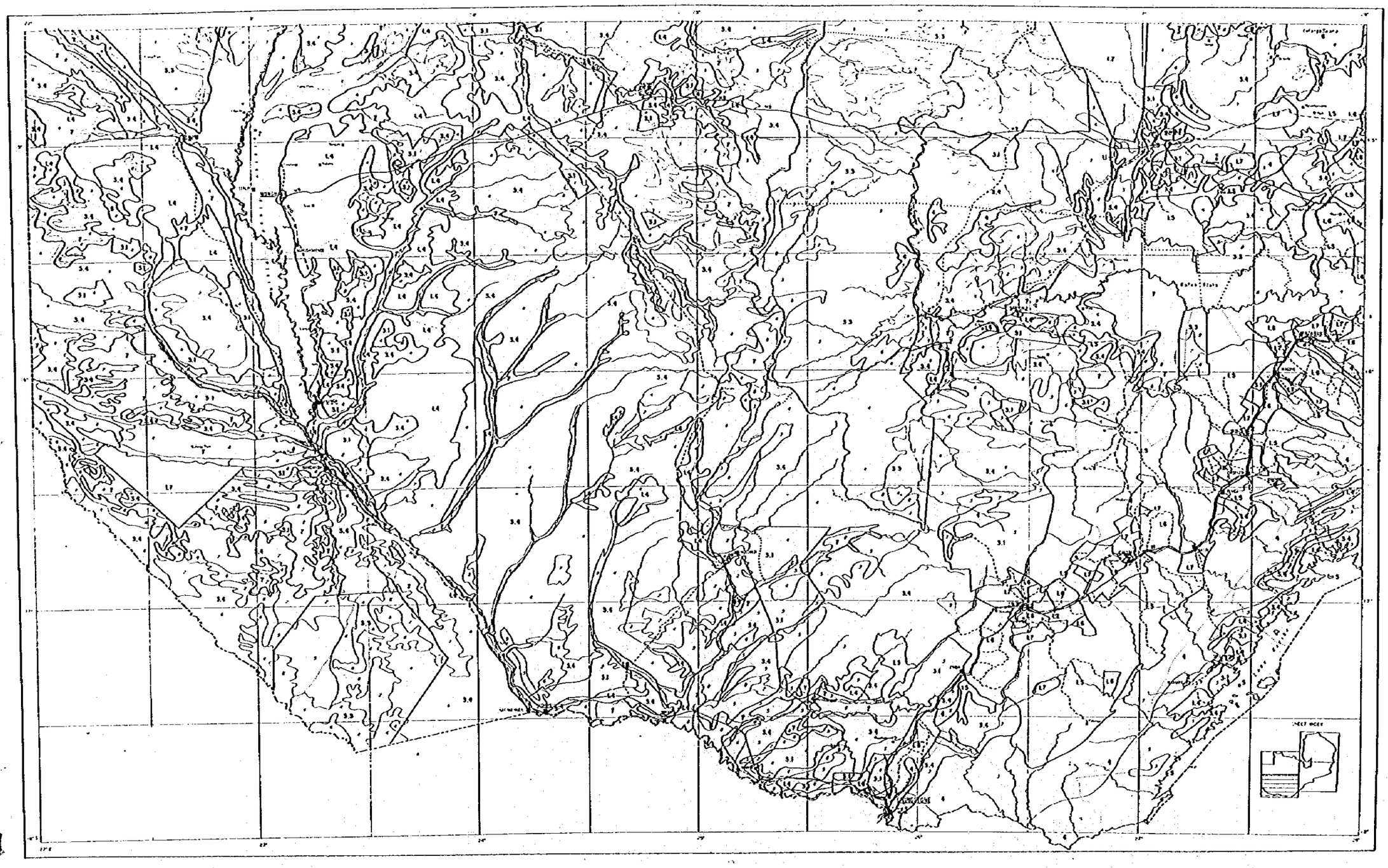
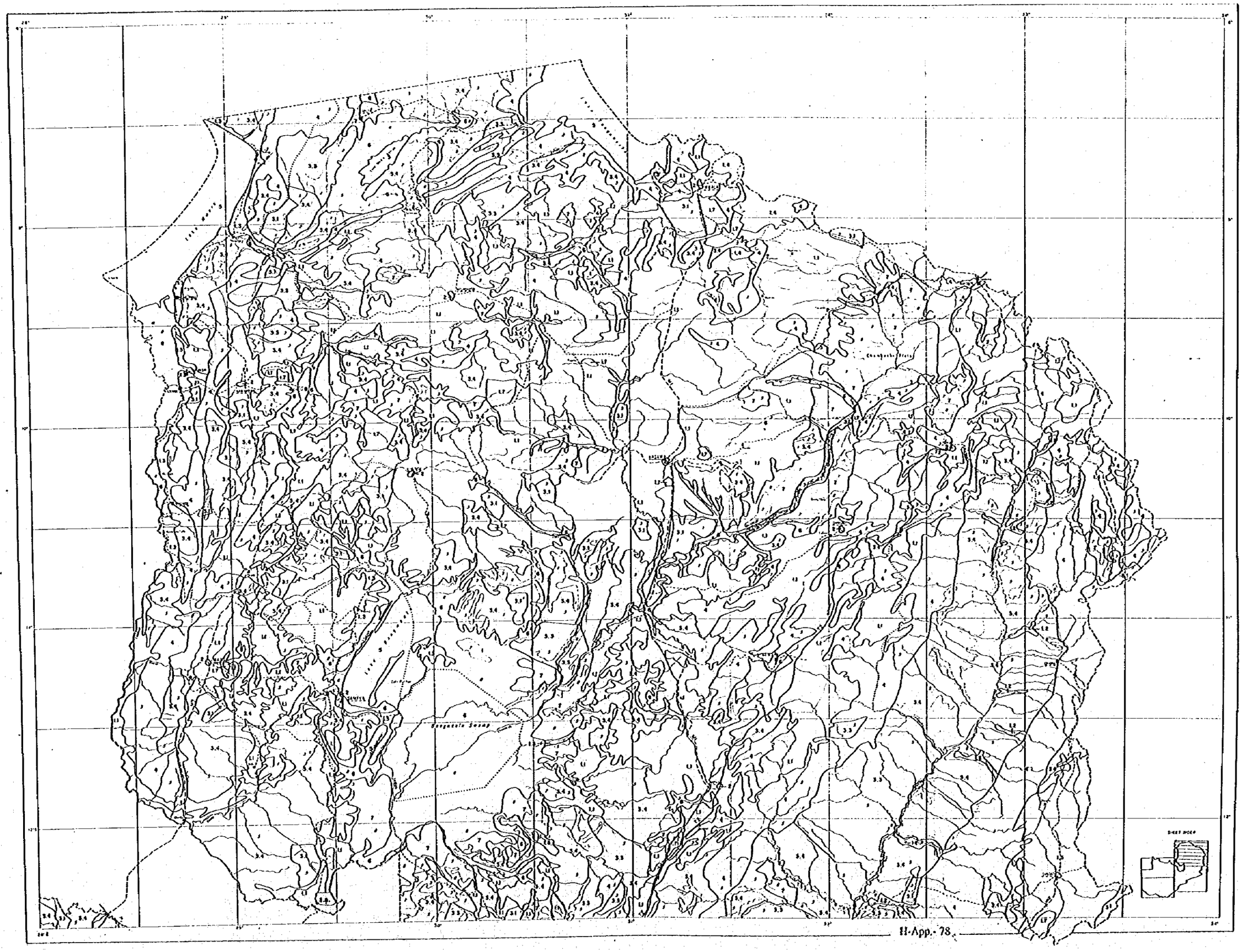
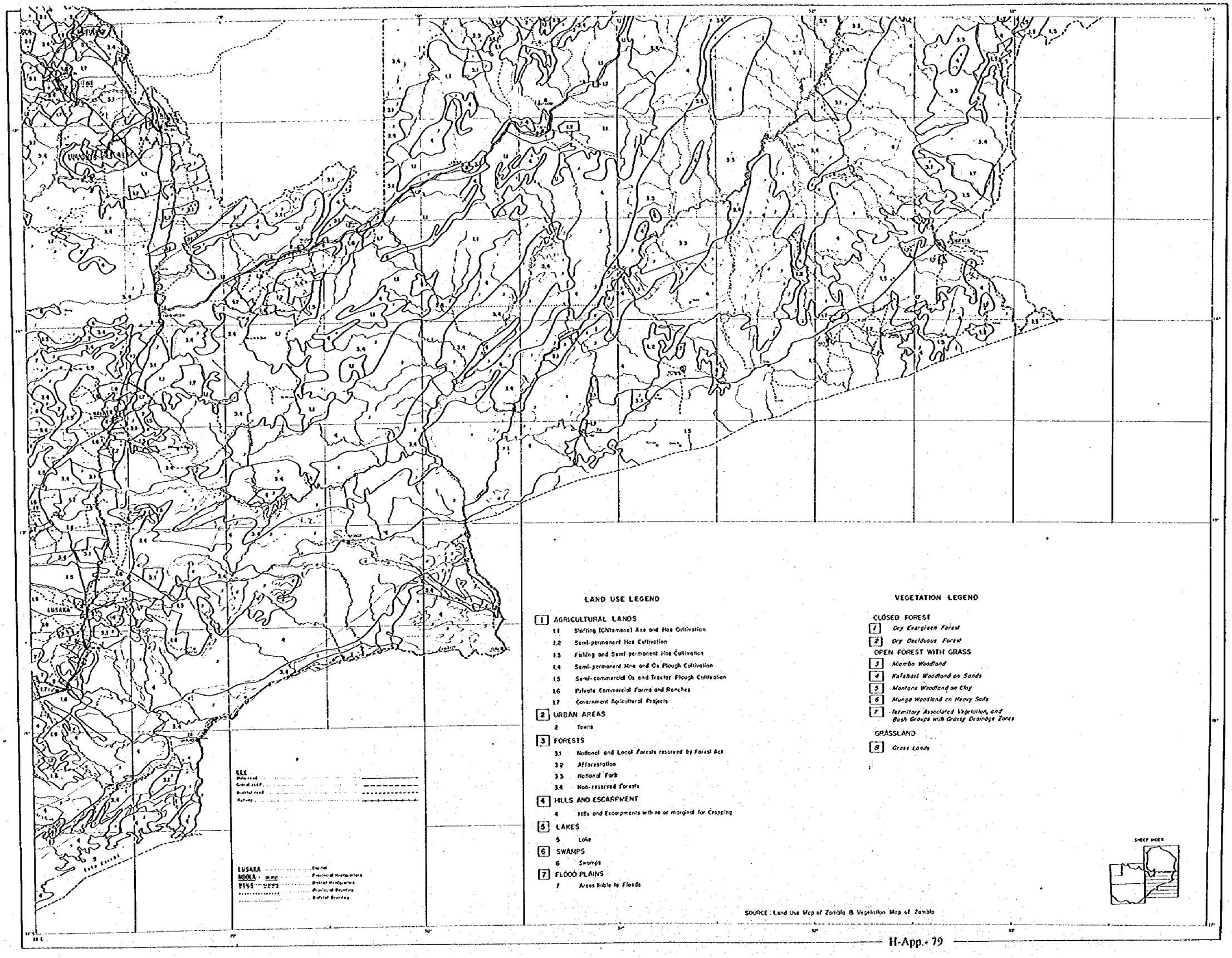
Kilometres









SOURCE : Land Use Map of Zambia & Vegetation Map of Zambia

Appendix-4 List of Donor Assisted Agricultural Projects

No.	Title of Projects	Category	Financier	Type of Finance	Start Year	End Year	Kwacha
1	CIDA-MA Planning Projects	Arip	Canada	C.V.Funds	1981	1992	5,000,000
2	National Early Warning System	F/S	FAO/ Netherlands	Grant	1982	1993	126,047,000
3	Support Agricultural Planning	Arip	Sweden	Grant	1979	1994	55,000,000
4	North-Western Area Development project	Iri	IFAD	Loan	1983	1999	259,460,000
5	Kabompo Irrigation Development Project	Iri	Sweden	Grant	1978	1993	49,760,000
6	Gwembe Irrigation Development Project	Iri	Germany	Grant	1987	1996	
7	Gwembe South Development Project	Iri	Gossner Mission	Grant	1972	1993	56,618,000
8	Soybean Research and Development	Res	Canada	Grant		1995	36,700,000
9	Adaptive Research	Res	Sweden	Grant	1982	1995	15,510,000
10	Agricultural Engineering	Res	Netherlands Sweden	Grant	1979	LT	284,795,000
11	Building Infrastuctural Research	Res	GRZ	GRZ	1974	LT	40,000,000
12	Cropping Research (Maize, Sorghum, Millet, Pasture and Vegetables)	Res	Sweden Norway Netherlands Germany	Grant	1980	LT	10,147,000
13	Cereal Research	Res	ITA (AFNETA) Canada	Grant	1980	LT	61,864,000
14	Fiber Research	Res	GRZ	GRZ	1980	LT	8,200,000
15	Food Legumes Research	Res	GRZ	GRZ	1981	LT	12,850,000
16	Oilseeds Research	Res	Sweden/ Canada	Grant	1981	LT	15,800,000
17	Plant Genetic Resources Research	Res	Canada	Grant	1980	LT	10,248,000
18	Root and Tubers Research	Res	Sweden	Grant	1986	LT	8,000,000
19	Tree and Plantation Crops	Res	GRZ	GRZ	1986	LT	28,500,000
20	Vegetable Protection Research	Res	Sweden	Grant	1985	LT	10,850,000
21	Plant Protection Research	Res	GRZ	GRZ	1981	LT	9,954,000
22	Livestock and Pasture Research	Res	Sweden	Grant	1985	LT	80,000,000
23	Soil Research	Res	Sweden	Grant	1981	1995	30,000,000
24	Zambia-China Rice Project	Res	China	Grant	1975	1993	10,600,000
25	Zambia-Canada Wheat Credit Scheme	Fin	Canada	Grant	1992	1993	26,225,000
26	Maize and Fertilizer Storage Phase II	Mkt	Canada	c.v. Funds			137,440,000
27	Animal Disease Control Project Eastern Province	Vet	EEC	Grant	1979	1992	
28	Animal Disease Control (Western Province)	Vet	Netherlands	c.v. Funds	1979	LT	41,150,000
29	Hides and Skins	Vet	GRZ	GRZ	1981	1995	12,400,000
30	Foot and Mouth Disease Control	Vet	EEC	Grant	1981	LT	30,150,000
31	Quarantine Services	Vet	GRZ	GRZ	1981	LT	8,850,000
32	Cattle Disease Control : Eastern Province	Vet	GRZ	GRZ	1986	LT	8,000,000
33	Corridor Disease Control	Vet	GRZ	GRZ	1989	LT	21,000,000
34	Cattle Development Programme (LP)	Vet	Netherlands	Grant	1989	1995	10,750,000
35	Economics of Tick and Tickborne Disease	Vet	FAO/ Denmark	Grant			100,000,000
36	National Artificial Insemination Services	Vet	Netherlands	Grant	1974	LT	20,300,000
37	Animal Vaccine Production	Vet	EEC	Grant	1986	1994	59,000,000
38	Veterinary Research	Vet	UNDP/IAA	Grant	1980	LT	77,100,000
39	Mazabuka Traditional Farm Development	Vet	Japan	Grant	1989	1995	3,633,000
40	Kalomo Tsetse Control	Vet	EEC	Grant	1985	1993	20,154,000
41	Regional Tsetse & Trypanosomiasis Control	Vet	EEC	Grant	1985	1995	50,900,000
42	SADCC Regional Training Centre For Trypanosomiasis	Vet	EEC	Grant	1989	1995	1,040,375,000
43	Agricultural Training (Monze)	Trn	Sweden	Grant	1979	1992	30,000,000
44	Agricultural Training (Mpika)	Trn	Sweden	Grant	1979	1992	30,000,000

No.	Title of Projects	Category	Financier	Type of Finance	Start Year	End Year	Kwacha
45	National Resources Development College	Trn	Sweden	Grant	1979	1992	33,000,000
46	Palabana Dairy Training Institute	Trn	Netherlands/EEC	Contribution / c.v.funds	1979	1992	20,659,000
47	Smallholder Development Project Copperbelt Province	Ext	EEC	Grant	1988	1993	342,248,000
48	Small Dairy Development Extension FAO	Ext	FAO	Grant	1983	1994	117,642,000
49	Rice Development (Northern Province)	Ext	EEC	Grant	1983	1994	117,642,000
50	Central Province Maize Development	Mkt	EEC	Grant	1982	1994	160,000,000
51	Fish Culture Adaptive Research	Fis	Norway	Grant	1987	1992	899,000
52	Lake Kariba SADCC Project	Fis	Norway Denmark	Grant	1991	1995	119,113,000
53	Fish Hatchery Project	Fis	Japan	c.v. funds	1991	1993	22,530,000
54	Aquaculture Project (N/Western Province)	Fis	UNDP/ AFRICARE	Grant			21,900,000
55	Lake Tanganyika	Fis	Finland	Grant	1992	1997	50,900,000
56	Lade Kariba Small Fisheries Development	Fis	Germany	Grant			7,280,000
57	Valley Development	Ext	GRZ	GRZ	1988	1998	6,585,000
58	Agricultural Irrigation, Research and Development	Iri	Netherlands	Grant	1984	1994	73,729,000
59	Irrigation Rehabilitation Scheme	Iri	FAO	Grant	1988	1998	4,000,000
60	Irrigated Production Program	Iri	GRZ	GRZ	1988	1998	3,000,000
61	Farm Block Development	Iri	GRZ	GRZ	1986	1996	23,645,000
62	Pig Development	Vet			1975	LT	11,520,000
63	Dairy Development	Vet			1974	LT	8,730,000
64	Batoka Dairy Cross Breeding Development	Vet	EEC	Grant	1979	1993	3,000,000
65	Poultry Development	Vet	GRZ	GRZ	1970	LT	8,100,000
66	National Soil Conservation & Agro-forestry extension	Frst	Sweden	Grant	1987	1992	227,000,000
67	Oxen Supply Training	Vet	GRZ	GRZ	1970	1996	9,630,000
68	Small Scale Wheat Extension	Ext	Canada	Grant/ c.v.funds	1989	1994	26,224,000
69	Women Agricultural Development	Ext	FAO	Contribution	1982	LT	6,200,000
70	Coffee II Development (Pipeline)	Iri	IDA	Loan	1992	1994	80,850,000
71	Irrigation Development Project (Eastern Province)	Iri	Sweden	Grant	1971	1993	2,260,000
72	World Bank Fisheries Development Project	Fis	IBRD	Grant	1985	1990	
73	Irrigation Development Project (Northern Province)	Iri	Sweden	Grant	1973	1993	2,260,000
74	Production of Disease Resistant varieties (Mt. Makulu)	Res	Belgium	Grant		1989	
75	Tsetse Applied Research Training Project	Vet	UNDP/ FAO	Grant	1985	1990	
76	Agricultural Mechanization (Eastern Province)	P&M	Italy	Grant	1990	1990	
77	Research and Development of Cashewnut	Res	Italy	Grant	1985	1990	
78	Agriculture for Local Community Development	Ext	Sweden	Grant	1987	1994	
79	Post harvest losses Control	Phv	UNDP	Grant	1987		
80	Irrigation Development Project (LP)	Iri	Sweden	Grant	1979	1992	
81	Livestock Development (Western Province)	Vet	Netherlands	Grant	1984		
82	Extension Training (Western Province)	Ext	Netherlands	Grant	1980		
83	Tsetse control Research Project	Vet	Netherlands	Grant	1986		
84	Village Agriculture Programme	Ext	Norway	Grant	1975	1991	
85	Soil Survey Unit	Res	Norway	Grant	1977	1991	
86	Support to Agricultural Engineering (Eastern Province)	Res	Sweden	Grant	1991	1994	125,000
87	Crop extension Lime, HQ	Ext	Sweden	Grant	1980	1990	

No.	Title of Projects	Cate-gory	Financier	Type of Finance	Start Year	End Year	Kwacha
88	Transfer of Crop Production technology global 2000	Res	BCCI(NGO)	Grant	1986	1991	
89	Kawambwa Tea Scheme	Ext	EEC	Grant	1977	1989	
90	Pilot Schemes Irrigation	Iri	Italy	Grant	1984		
91	Marketing Management Assistance for Food Security	Mkt	FAO	Grant	1989		
92	Dam construction and Machinery for LDS	Iri	Japan	Grant	1988		
93	Input Support Programme	Fin	EEC	Grant	1987		
94	Technical Assistance to N/Western Province Area Development Project	Iri	IFAD	Grant	1983	1989	
95	Assistance to Agricultural Production Units in Draught Areas	F/S	FAO	Grant	1987		
96	Cotton Research	Res	France	Grant	1981	1992	
97	Zambezi Training Farm College	Trn	Italy	Grant	1985		
98	Supply of Veterinary Drugs and Transport Vehicles	Vet	Italy	Grant	1987		
99	Extension Training Officer	Ext	Netherlands	Grant	1984		
100	Women's Extension Project (TA)	Ext	Netherlands	Grant	1982	1990	
101	Rehabilitation of Mongu Abattoir	Vet	Netherlands	Grant			
102	Lake Kariba Fisheries, research and development	Fis	SADC/ Germany	Grant	1991	1995	
103	Assistance to MOA Planning Division Monitoring and Evaluation	Arip	UK	Grant	1987	1990	
104	Fisheries Research (OSAS)	Fis	UK	Grant	1979	1991	
105	Veterinary services and Tsetse Control (OSAS)	Vet	UK	Grant	1985	1991	
106	Rehabilitation of Massey Fergusson Tractors Phase II	P&M	UK	Grant	1988		
107	Zambia Agricultural Training Planning and Development	Ext	USA	Grant	1987	1993	
108	Training Field Personnel in Tsetse and Trypanosomiasis	Vet	FAO	Grant (TA)			
109	Strategic tick Control and immunisation against tick borne diseases	Vet	Denmark	Grant			
110	Crop Extension Lima (Northern Province)	Ext	Sweden	Grant			
111	Crop Extension, Lima (L/P)	Ext	Sweden	Grant			
112	Farm Management Support Project	Ext	UK	Grant			
113	Agricultural Marketing and Processing Infrastructure Project	Mkt	IBRD	Loan	1992	1997	8,500,000,000
114	Wheat Development Project Phase II	Ext	Canada	Grant		1993	
115	Smallholder Development Project (Central Province)	Ext	EEC	Grant		1994	
116	People's Participation	Ext	Netherlands	Grant		1994	
117	Maize and Food Legume Improvement	Res	UNDP	Grant		1992	
118	Strengthening of Technical Support to Agricultural Extension Services	Ext	UNDP	Grant (TA)		1992	
119	Agricultural Extension and Training Programme	Ext	Finland	Grant		1992	
120	Animal Draught Power/Cattle Development	P&M	Finland	Grant			
121	Irrigation Development Project (N/Western Province)	Iri	Germany	Grant		1993	
122	Animal Power Technology Project	P&M	Germany	Grant		1993	
123	Smallholder Dairy Development Project	Vet	IBRD	Loan	1982		16,758,000
124	Zambia Agriculture Research and Extension Project	Res	IBRD/ADF/Norway	Loan/Grant	1987	1995	2,881,540,000
125	Smallholder Services Rehabilitation	Ext	IFAD	Loan		1995	
126	Kaunga Rural Development Project	Iri	Japan	Grant	1987	1994	
127	Agricultural Verification Study for Development of Rice	Res	Japan	Grant	1988	1992	

No.	Title of Projects	Cate-gory	Financier	Type of Finance	Start Year	End Year	Kwacha
128	Agricultural Village development (Kanakantapa)	Iri	Japan	Grant	1990	1996	
129	Macha Cattle development Area	Ext	Netherlands	Grant		1993	
130	Senanga District Support Programme	Iri	Netherlands	Grant		1995	
131	Adaptive Research Planning Team	Res	Netherlands	Grant		1994	
132	Kalabo Agricultural Project Phase II	Iri	Netherlands	Grant		1992	
133	Land and Water Management Project	Iri	Netherlands	Grant		1994	
134	Adaptive Research and Development	Res	Netherlands	Grant		1992	
135	Draught Power (Western Province)	P&M	Netherlands	Grant		1992	
136	National Animal Draught Power Co-ordination Program	P&M	Netherlands	Grant		1995	
137	Palabana Animal Draught Power Training Project	P&M	Netherlands	contribution s/ c.v. funds		1992	
138	Rice Promotion Programme in Lui valley	Res	Netherlands	Grant		1994	
139	Oils Seeds Development Project	Res	AFRICARE (NGO)	NGO			
140	Given Training Farm	Trn	SNV (NGO)	NGO			
141	Community Development	Ext	Harv Help (NGO)	NGO			
142	Catholic Agricultural Rural Youth Movement	Iri	Roman Catholic church (NGO)	NGO			
143	Extension and Training Support Programme	Ext	Norway	Grant		1995	
144	Adaptive Research Planning Team	Res	Norway	Grant		1995	
145	Soil Productivity Research Programme	Res	Norway	Grant		1996	
146	Support to Agricultural Engineering, HQ	Res	Sweden	Grant		1992	
147	Women in Development	Ext	Sweden	Grant	1982	1992	
148	Seed Control and Certification Institute	Res	Sweden	Grant		1992	22,570,000
149	Seed Training Programme	Res	Sweden	Grant		1992	21,000,000
150	Support to ARPT, HQ	Res	Sweden	Grant		1995	
151	ARPT Nutrition	Res	Sweden	Grant		1995	
152	Support to ARPT - Luapula Province	Res	Sweden	Grant		1995	
153	Support to ARPT - Eastern Province	Res	Sweden	Grant		1992	
154	Assistance to NRDC	Trn	UK	Grant		1992	
155	Adaptive Research planning Team	Res	UK	Grant		1993	
156	Land Use Planning (OSAS)	Arip	UK	Grant		1992	
157	Support to Mechanisation & Tillage Research (OSAS)	Res	UK	Grant		1993	
158	Household Food Production, Nutrition and Income Generation	F/S	UN	Grant (TA)		1992	
159	Assistance to Soil Science Department	Res	USA	Grant		1992	
160	Support to Department of Agriculture	Arip	Germany	Grant			
161	Integrated Rural Nutrition Project	Iri	Germany	Grant		1994	
162	Luangwa IRDP Phase II (MOA Components)	Iri	Norway	Grant			
163	Siavonga Agriculture & Agroforestry Development	Frst	Germany	Grant		1994	
164	Cinci Wa Babili Farming Project	Iri	Roman Catholic church (NGO)	NGO		1993	
165	Strengthening Food Security & Nutrition monitoring	F/S	FAO	TA		1993	
166	Masese Agricultural Project	Iri	Netherlands	Grant		1992	
167	Export Diversification	F/S	World Bank	Loan	1992	1995	4,138,500,000
168	Horticultural Development	Ext	GRZ	GRZ	1975	LT	19,000,000
169	International Red Locust Organization	Vet	GRZ	GRZ			88,200,000

No.	Title of Projects	Cate-gory	Financier	Type of Finance	Start Year	End Year	Kwacha
170	Water Reticulation and Fencing	Fis	GRZ	GRZ			3,000,000
171	Fish Culture Development Project	Fis	Netherlands	Grant	1987	1992	22,735,000
172	Fisheries Building	Fis	GRZ	GRZ	1986	1996	10,910,000
173	Restocking of Itezhi-tezhi Dam	Fis	GRZ	GRZ	1990	1992	4,700,000
174	Fish Development Project	Fis	GRZ	GRZ	1985	1994	10,000,000
175	Chapula Horticulture Training Centre	Trn	GRZ	GRZ		LT	12,910,000
176	Kalulushi Farm College	Trn	GRZ	GRZ			17,000,000
177	Popota Tobacco College	Trn	GRZ	GRZ		LT	27,084,000
178	Agricultural Communication Centre	Ext	GRZ	GRZ	1992	1994	300,000,000
179	Golden Valley Research Programme	Res	GRZ	GRZ			15,000,000
180	Staff Housing MAFF (Construction)	Ext	GRZ	GRZ	1975	LT	239,286,000
181	Credit Facilities to Small Scale Farmers	Fin	GRZ	Loans		LT	1,000,000,000
182	Field Education	Ext	Sweden	Grant		LT	8,505,000
183	Co-operative Development Fund	Fin	GRZ	GRZ		LT	
184	Cattle Marketing (Western Province)	Mkt	GRZ	GRZ		LT	
185	Rural Storage Facilities	Mkt	GRZ	GRZ		LT	
186	Katete Training College (Rehabilitation)	Trn	GRZ	GRZ		LT	500,000
187	Mazabuka Institute of Animal Science	Vet	GRZ	GRZ		LT	10,998,000
188	Chilubi Fish Development	Fis	GRZ	GRZ		LT	
189	Women's Appropriate Technology Programme	Ext	GRZ	GRZ		LT	
190	Nyangombi and Fiwandu Development Programme	Ext	GRZ	GRZ		LT	
191	Tazara Corridor	Ext	GRZ	GRZ		LT	
192	Buleya-Malima Irrigation Scheme	Iri	GRZ/GSDP	GRZ & Grant	1981	LT	
193	Staff Accommodation (Rehabilitation) MAFF	Ext	GRZ	GRZ	1975	LT	5,000,000
194	Agricultural Provincial Buildings	Ext	GRZ	GRZ			10,800,000
195	Aquaculture for Local Community	Fis	GRZ	GRZ			5,500,000
196	Planning, Feasibility Studies and Monitoring	Res	Sweden	Grant	1980		
197	Agricultural Surveys and Planning	Arip	GRZ	GRZ			2,800,000
198	Forest Resources Management Study for Zambia Teak Forests in South-Western Zambia	Frst	Japan	Grant	1993	1995	
199	Mongu Rural Development	Arip	Japan	Grant	1994	1995	
200	Veterinary Medicine Research Study	Vet	Japan	Grant	1993	1996	

(Note) Arip: Agricultural Planning, Ext: Extension, F/S: Food Security, Fin: Financial, Fis: Fisheries
Frst: Forestry, Iri: Irrigation, Mkt: Marketing, P&M: Animal Power & Mechanisation
Phv: Post Harvest, Res: Research, Trn: Training, Vet: Veterinary

JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF ZAMBIA
MINISTRY OF ENERGY AND WATER DEVELOPMENT

THE STUDY

ON

THE NATIONAL WATER RESOURCES MASTER PLAN

IN

THE REPUBLIC OF ZAMBIA

SUPPORTING REPORT [I]

IRRIGATION

OCTOBER, 1995

YACHIYO ENGINEERING CO., LTD.
(YEC)

THE STUDY ON NATIONAL WATER RESOURCES MASTER PLAN
IN THE REPUBLIC OF ZAMBIA

SUPPORTING REPORT (I)
IRRIGATION

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CHAPTER 1 PRESENT STATUS OF IRRIGATION

1.1 Irrigation Projects in Zambia

1.1.1 Total Irrigation Area

History of irrigation development is not so long in Zambia. Irrigation development was initiated in early 1960s, and proceeded by both sectors of Government and commercial basis. Government or state irrigation projects were vigorously executed in late 1960s and in 1970s.

There is no accurate information on acreage of irrigated area and location at this stage. However, some of important and valuable information have been given from Land Husbandry Section, Department of Agriculture (DOA), Ministry of Agriculture, Food and Fisheries (MAFF). For encouraging those data, present irrigation status was surveyed in the current water use survey and the water right survey. Questionnaire survey was additionally conducted for commercial farmers. However, the questionnaire survey was not able to obtain good results due to limited number of answers (about 25%). Present status of irrigation has been estimated by the current water use survey for the government projects and by the water right survey for the total irrigation acreage and water use in Zambia. The national total irrigated area is estimated at 53,020 ha at present. Out of the national total, commercial sector is estimated achieving 58% or 30,820 ha of irrigation, while the government achieving 42% or 22,200 ha. Consequently, commercial sector contributes more than the government on irrigation development. Provincial composition of irrigated areas is summarised in Table 1-1.

Present Irrigated Area in Dry Season

Total Irrigated Area: 53,020 ha (Dry Season Crop)
Commercial Farms: 30,820 ha (58 %)
Government Irrigation Projects: 22,200 ha (42 %)
Small Holders Irrigation Projects: 210 ha (1.0%)
Medium Scale Irrigation Projects: 1,690 ha (7.6%)
Large Scale Irrigation Projects: 20,300 ha (91.4%)

Table 1-1 Estimated Dry Season Irrigation by Province

District	Irrigation in Dry Season (ha)		Water (1000 m3/day)	Wheat (ha)	Sugar cane (ha)	Coffee (ha)	Tea (ha)	Citrus Fruits (ha)	Banana (ha)	Vegetables (ha)	Flowers (ha)
10 Lusaka	5,674	10.7%	490	3,327	0	22	0	336	44	1,736	209
20 Copperbelt	9,294	17.5%	803	2,978	0	1,057	0	1,684	46	3,493	36
30 Central	6,525	12.3%	564	2,585	0	349	0	1,315	13	2,263	0
40 N/Western	522	1.0%	45	0	0	215	0	42	10	255	0
50 Western	7	0.0%	0	0	0	0	0	0	0	0	0
60 Southern	19,222	36.3%	1,661	4,616	13,000	485	0	462	72	594	0
70 Luapula	2,139	4.0%	185	0	0	403	140	578	320	695	3
80 Northern	9,143	17.2%	790	0	0	3,643	0	2,631	453	2,415	1
90 Eastern	497	0.9%	43	150	0	11	0	107	17	212	0
Zambia	53,023	100.0%	4,581	13,656	13,000	6,185	140	7,155	975	11,663	249
	100.0%			25.8%	24.5%	11.7%	0.3%	13.5%	1.8%	22.0%	0.5%

(Note) Irrigated area is estimated by Water Right Survey 1994 shown Table 1-14. (Irrigated area as of 1993)

As shown in Table 1-1, the irrigated area is concentrated to Southern Province at about 36 %, and followed by Copperbelt and Northern at 17.5 and 17.2% respectively. Western Province is the most behind in irrigation development that irrigation is not yet developed. Eastern, North-western and Luapula Provinces are also behind in irrigation development sharing 0.9%, 1.1% and 4.0% respectively.
Table 1-2 shows the composition of irrigation areas of both sectors of government and commercial farms.

Table 1-2 Sector Composition of Irrigated Area by Province

Province	Government Irrigation Project (1)		Commercial Farms (2)		Total Irrigation Area (3)	
	(ha)	(%)	(ha)	(%)	(ha)	(%)
10 Lusaka	2,270	10.2%	3,404	11.0%	5,674	10.7%
20 Copperbelt	4,301	19.4%	4,993	16.2%	9,294	17.5%
30 Central	8	0.0%	6,517	21.1%	6,525	12.3%
40 N/Western	10	0.0%	512	1.7%	522	1.0%
50 Western	7	0.0%	0	0.0%	7	0.0%
60 Southern	14,714	66.3%	4,508	14.6%	19,222	36.3%
70 Luapula	563	2.5%	1,576	5.1%	2,139	4.0%
80 Northern	321	1.4%	8,822	28.6%	9,143	17.2%
90 Eastern	8	0.0%	489	1.6%	497	0.9%
Zambia	22,202	42%	30,821	58%	53,023	100%

(Note)
(1): Referring to Table 1-8.
(2): Subtracting Governmental Irrigation Project from Total Irrigated Area.
(3): Referring to Table 1-1.

Figures 1-1 and 1-2 show the provincial composition of irrigation projects of both sectors. Government irrigation projects are concentrated to Southern Province. Its share reaches to 66% of total government irrigation area, but contrarily less allocation in other provinces.

Figure 1-1 Distribution of Governmental Irrigation Projects

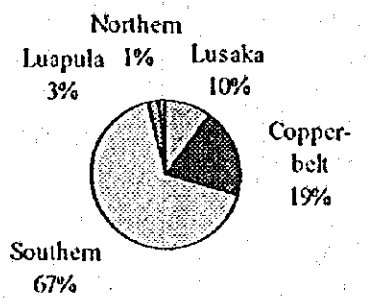
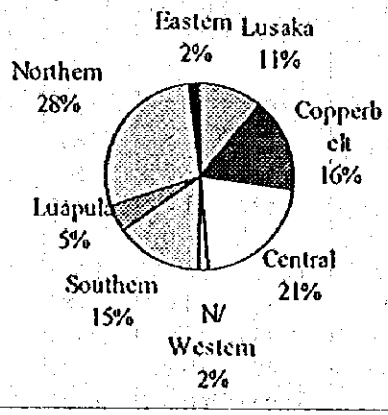


Figure 1-2 Distribution of Commercial Irrigation Farms



On the other hand, as shown in Figure 1-2, the irrigated commercial farms distribute more uniformly to the country. It is remarkable that the share of Northern Province reaches to

28%, that is the largest share in the country, followed by Central, Copperbelt and Southern Provinces.

From present status of irrigation mentioned above, present conditions of irrigation are considered as following:

a) In the northern region, irrigation development will be more expanded by commercial basis, if the rural road and electric networks are improved or expanded more, because stable and cheaper water resources are existing such as perennial river flow and adequate rainfall in rainy season.

b) Although the southern region is closer to the large market, such as Lusaka, the share of commercial irrigated farms is low comparing to the number of commercial farmers. In the southern region, especially in Southern Province, water right is so severe that irrigation expansion is restricted by less water availability and difficulty on issue of water right.

As shown in Table 1-3, the irrigated area is concentrated into the Kafue River basin, that shares more than half of the total irrigated area of the country. The irrigated area is scarce in the main stream basin of the Luangwa, but concentrated in the tributary basin Lunsemfwa in Central Province. The Luapula and Chambeshi river basin shares 22.6% of the national total.

Table 1-3 Irrigated Area by River Basins

River Basin	Tanganyika	Chambeshi	Luapula	Kafue	Luangwa	Zambezi	Eastern	Total
Irrigated Area (ha)	373	5,954	5,401	30,007	8,488	2,774	23	53,020
Percent (%)	0.7	11.2	10.2	56.6	16.0	5.2	0.1	100.0

(Note) Details are described in Table 1-15.

1.1.2 Government Irrigation Projects

(1) Categories of Government Irrigation Projects

A list of government irrigation projects was obtained from the DOA. By the list, there are 44 government (state) irrigation projects in Zambia. The state irrigation projects are generally classified into following four categories.

Table 1-4 Classification of Government Irrigation Projects

State Irrigation Projects	Approx. Irrigated Area (ha)	Beneficiaries	Number of Projects	Present Acreage (ha)
1. Large Scale Projects	over 2,000	State Companies	6 Projects	20,300
2. Medium Scale Projects	100 to 2,000	State Companies	7 Projects	1,693
3. Small Holders Projects	2 to 100	Small holder farmers	31 Projects	209
4. Small Scale Projects	less than 2	Small holder farmers	Unknown	-
Total			44 Projects	22,202

(note) Details are shown in Table 1-8 to 1-11.

There exist large number of small scale irrigation projects through the country, but exact number and present status are not known by the DOA. In above categories, acreage

classification is not defined so clear in MAFF. The large and medium scale irrigation projects are now privatised under liberalisation of the government policy. The large and medium scale irrigation projects are generally operated effectively. However, the small holders irrigation projects are not fully operated in the most cases due to many reasons of difficulty. Some small holders irrigation projects are not operated due to financial and equipment difficulties.

(2) Acreage of Government Irrigation Projects by Category

Table 1-5 shows the acreage of government irrigation projects by the scale of project in each province. As shown in the table, almost government irrigation is shared by the large scale irrigation projects in all provinces.

Table 1-5 Government Irrigation Area by Scale of Project and by Province

Province	Irrigation Area by Scale (ha)			
	Large	Medium	Small-Holders	Total
Lusaka	2,000	220	50	2,270
Copperbelt	3,000	0	1	3,001
Central	1,300	0	8	1,308
N/Western	0	0	10	10
Western	0	0	7	7
Southern	14,000	610	104	14,714
Luapula	0	553	10	563
Northern	0	310	11	321
Eastern	0	0	8	8
Total	20,300	1,693	209	22,202

(Note) Detailed in Table 1-9.

(3) Large and Medium Irrigation Schemes

Table 1-6 presents the list of large and medium scale irrigation projects. There are 6 large scale irrigation projects and 7 medium scale irrigation projects, totally 13 projects. Total irrigation area is about 22,000 ha. Out of 22,000 ha, the large scale irrigation projects share 92% of total area.

Major irrigated crops in these projects are sugarcane, wheat and cotton in the large scale irrigation projects, while coffee, banana and tea in the medium scale irrigation projects. Since sugarcane, wheat and cotton can be extensively cultivated by a large mechanised farming system, those crops are cultivated in the large scale irrigation projects. On the other hand, other labourable crops such as coffee, banana and tea are cultivated in the medium scale irrigation projects. However, such labourable crops give much higher value added than former crops. Due to decline of wheat and cotton prices, crop diversification has been practised in the large scale irrigation projects. It is reported that wheat and cotton have been abandoned and diversified to flowers (marigold) and paprika in Masstock Irrigation Project. Such crop diversification will be important to manage the large irrigation project.

According to the Current Water Use Survey, total water use of large and medium scale

irrigation projects is reported at 24.00 m3/sec. Unit irrigation rate is estimated at about 1.0 lit./sec/ha from water use.

Table 1-6 Large and Medium Scale Irrigation Projects

Project Name	Province	Water Use		River	Area	Crops
Large Scale Irrigation Project		(m3/sec)	(Lit/sec/ha)		(ha)	
1 Mpongwe	Central	0.97	0.75	Groundwater	1,300	2,3,4
2 Kaleya	Southern	0.25	0.13	Kafue	1,900	6
3 Nakambala	Southern	12.74 *1	1.07	Kafue	11,900	6
4 Masstock	Lusaka	2.00 *	(1.00)	Kafue	2,000	1,3
5 Gwembe	Southern	2.10 *	(1.00)	Lake Kariba	2,100	1,3
6 Munkumpu	Copperbelt	3.00 *	(1.00)	Lupala	3,000	3
Sub-Total		21.06	1.04		20,300	(92%)
Medium Scale Irrigation Project		(m3/sec)	(Lit/sec/ha)		(ha)	
1 Nanga	Southern	1.75	2.87	Kafue	610	1,2,3
2 Zambia Coffee	Northern	0.21	0.68	Lukupa,	310	2
3 (2 projects)				Kabulukuto		
4 Kawambwa Tea	Luapula	0.66	1.46	Luano	453	5
5 Mununshi Banana	Luapula	0.10 *	(1.00)	Mununshi	100	7
6 Chiawa	Lusaka	0.02 *	(1.00)	Zambezi	20	7
7 Chanyanya	Lusaka	0.20 *	(1.00)	Kafue	200	8
Sub-Total		2.94	1.73		1,693	(8%)
Total		24.00	1.09		21,993	(100%)

(Notes) 1) *1: Including Kaleya and Mazabuka Councils. * : Estimated.
Crops: 1 = cotton 2 = coffee 3 = wheat 4 = soybean 5 = tea 6 = sugarcane
7 = banana 8 = Rice

(4) Smallholders Irrigation Projects

A list of smallholders irrigation projects was also provided by the Ministry of Agriculture, Food and Fishery.

Table 1-7 Smallholders Irrigation Projects

Province	Number of Projects	Present Irrigation (ha)	Total Irrigable (ha)	Present Water Use (lit/sec)	Future Water Use (lit/sec)
Lusaka	3	50	140	50	140
Copperbelt	3	1	141	1	141
Central	1	8	8	8	8
N/Western	1	10	300	10	300
Western	2	7	17	7	17
Southern	7	104	193	104	193
Luapula	8	10	118	10	118
Northern	1	11	1,000	11	1,000
Eastern	5	8	41	8	41
Total	31	209	1,958	209	1,958

(Note)
1) Water use is estimated at 1.0 lit/s/ha.
2) Detail descriptions are listed in Table 1-9.

Smallholders irrigation projects are counted to 31 projects in the country, but present operational acreage is only 209 ha because most of projects are not well operated due to various difficulties on financial, technical and organisational aspects. To solve and improve

such difficulties, DOA reported to FAO that the key factor for solution is to establish and encourage the farmers association for operation and maintenance of the project.

These smallholders irrigation projects are generally packaged with the resettlement projects, which aim the people able to settle sustainablly shifting from other places. Those resettlement projects have been implemented by various following aims:

<Aims for Resettlement Projects>

- removing the people from the shifting cultivation area to conserve forests, and to ensure farmers stable farming.
- to provide farms as possible earning measures to young people or retired men for stable life.

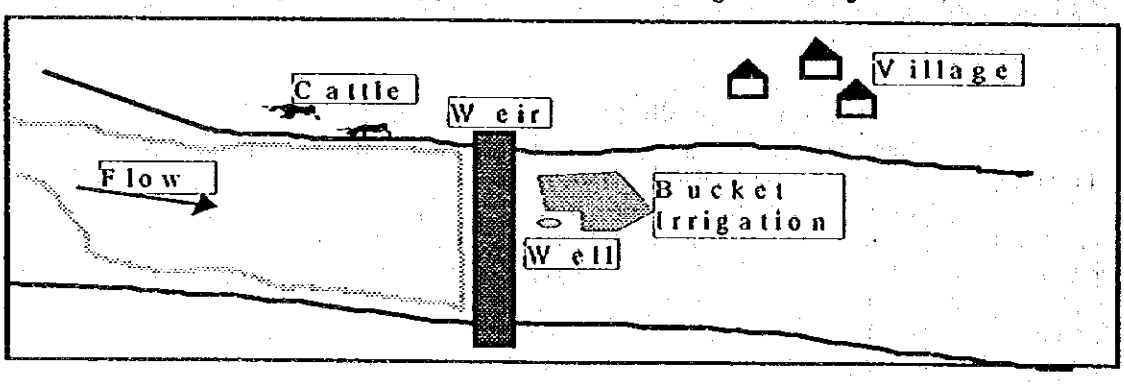
Present water use of these smallholders irrigation projects is very limited at about 0.21 m3/sec due to non-operation of project in most cases. However, it will increase to about 2.0 m3/sec if operated fully.

Small Scale Irrigation Projects

A large number of the small scale irrigation projects are scattered in the country. However, exact information of these projects is not available.

This project aims to supply water to small individual village for domestic, cattle and supplemental irrigation water during dry season as well as in rainy season. Figure 1-3 shows the typical small scale irrigation project.

Figure 1-3 Typical Small Scale Irrigation Project



The small scale irrigation projects were constructed in all provinces vigorously in 1970s. However, the small scale irrigation projects have not been constructed since late 1970s. The projects are now under no care of the government, and no records are remained in MAFF. The projects were surveyed in the current water use survey, but no information were obtained from the Provincial Agricultural Office on the projects.

The reasons of abandon of the small scale irrigation projects are summarised as below:

a) The project works well during rainy season, but it dries up within few months after rainy season due to shallow storage of water by evaporation and seepage.

b) The weir height is limited at 5 m height in this project. Therefore, storage water depth is too shallow to keep water during dry season.
c) The villager faces to severe difficulty on maintenance of irrigated crops mainly vegetables for home consumption and cattle water.

Table 1-8 List of Irrigation Schemes by The Government of Republic of Zambia

Province	Operational Schemes				Non-operational Schemes			Schemes under Implementation		
	No.	Scheme	Irrigated (ha)	Planed (ha)	No.	Scheme	(ha)	No.	Scheme	(ha)
10 Lusaka	O- 1	Chiawa	20	40	N- 1	Chipapa	10			
	O- 2	Chanyanya	200	1,000						
	O- 3	Masstock	2,000	3,000						
	O- 4	Kanakantapa	30	30						
	O- 5	Kaunga	20	100						
20 Copperbelt	O- 6 *1)	Mpongwe Development Company	1,300	3,500	N- 2 *1)	Ipafu	80			
	O- 7	Mankumpu Irrigation Project (Nchanga Farms)	3,000	5,000						
	O- 8 *1)	Masaiti Farm Institute	1	1						
	O- 9 *1)	Chapula	0	60						
30 Central	O- 10 *1)	Mutambaule	8	8						
40 N/Western	O- 11	Ikelenge Pineapple Irrigation Scheme	10	300						
50 Western	O- 12	Namushakende	7	7				I- 1	Nakatoya	10
60 Southern	O- 13 *1)	Kaleya Small Holders Company	1,900	2,200	N- 3	Kafwambila				
	O- 14	Buleya Malima	23	80	N- 4	Chiyabi	10			
	O- 15	Siatwinda	18	40						
	O- 16	Lusitu	13	13						
	O- 17	Zambezi Training Farm	40	40						
	O- 18 *1)	Nakambala Sugar Estates	10,000	17,000						
	O- 19	Gwembe Development Company	2,100	2,100						
	O- 20 *1)	Nanga	610	1,750						
	O- 21 *1)	Nkandabwe	10	10						
70 Luapula	O- 22 *1)	Kawambwa Tea Scheme	453	500	N- 5	Kenani Vegetable Scheme	8	I- 2	Mansa Pilot Scheme	10
	O- 23	Munonshi Banana Scheme	100	100	N- 6	Chiposa Mubende Scheme	10	I- 3	Kamani Coffee Scheme	
	O- 24	Mulumbi Coffee Scheme	10	70	N- 7	Chembe Vegetable Scheme	10	I- 4	Kazembe	
					N- 8	Chama Vegetable Scheme	10			
80 Northern	O- 25 *1)	Lukulu North	11	1,000						
	O- 26 *1)	Ngoli Coffee	*2)	*2)						
	O- 27 *1)	Kateshi Coffee	310	800						
90 Eastern	O- 28	Makungwa	5	5	N- 9	Mwase				
	O- 29	Lukuzye	0	10						
	O- 30	Vuu	3	16						
	O- 31	Lusowe	0	10						
10 Lusaka	5 Projects		2,270	4,170	1 Projects		10	0 Projects		0
20 Copperbelt	4 Projects		4,301	8,561	1 Projects		80	0 Projects		0
30 Central	1 Projects		8	8	0 Projects		0	0 Projects		0
40 N/Western	1 Projects		10	300	0 Projects		0	0 Projects		0
50 Western	1 Projects		7	7	0 Projects		0	1 Projects		10
60 Southern	9 Projects		14,714	23,233	2 Projects		10	0 Projects		0
70 Luapula	3 Projects		563	670	4 Projects		38	3 Projects		10
80 Northern	3 Projects		321	1,800	0 Projects		0	0 Projects		0
90 Eastern	4 Projects		8	41	1 Projects		0	0 Projects		0
Total	31 Projects		22,202	38,790	9 Projects		138	4 Projects		20

(Note) 1) Acreage is not defined in case blank, 2) Acreage depends on MAFF except *1 and *2 (*1, *2: Current Water Use Survey)
2) *2: Area of Ngoli is included in the area of Kateshi 3) Locations are shown in Figure 1-4.

Table 1-9 List of GRZ Irrigation Schemes classified by Water Development Method

Project Category Code	Project Name			Location Code	District	Province	Zambia Drainage	Water Source: River	Stream	Lake	Dam	Weir	G.Water	Intake Facility	Conveyance Facility	Irrigated (ha): Future	Present
Small Holders Schemes																1,958	209
S- 1	Kanakantapa	O-1		12	Lusaka Rural	Lusaka	AZ-20		Kanakantapa			Weir		Pump	Pipeline	30	3
S- 2	Chipapa	N-1		12	Lusak Rural	Lusaka	AK-11		o		2 Dams					10	0
S- 3	Kaunga	O-5		13	Luangwa	Lusaka	AL-8		Kaunga			Weir		Gravity	Pipeline/ Canals	100	2
S- 4	Masaiti Farm Institute	O-8	*	22	Ndola Rural	Copperbelt	AK-5	Kafue	Kamwense		Dam			Pump		1	1
S- 5	Ipafu	N-2	*	24	Chingola	Copperbelt	AK-1		Ipafu					Pumps	Pipeline	80	0
S- 6	Chapula	O-9	*	26	Kalulushi	Copperbelt	AK-1		o					Pumps	Pipeline	60	0
S- 7	Mutambatufe	O-10	*	35	Serenje	Central	AL-5		Mutambatufe			Weir		Gravity	Canal	8	5
S- 8	Bwenge	O-11		42	Mwinilunga	N.Western	AZ-1		Sakeji			Weir		Gravity	Canal	300	10
S- 9	Samushakende	O-12		51	Mongu	Western	AZ-13		Canal					Gravity	Canal	-	-
S- 10	Nakaoya	I-1		53	Kalabo	Western	AZ-12		N Loeh							10	0
S- 11	Kafwambila	N-3		65	Chama	Southern	AZ-18		Zhima		Dam				Pipeline		0
S- 12	Lusitu	O-16		67	Siavonga	Southern	AZ-19	Zambezi						Pumps	Canal	13	13
S- 13	Zambezi Training Farm	O-17		67	Chirundu	Southern	AZ-19	Zambezi						Pumps	Pipeline/ Canal	10	1
S- 14	Chiyabi	N-4		68	Gwembe	Southern	AZ-18	Zambezi		Kariba				Pumps	Canals	10	0
S- 15	Buleya Malima	O-14		69	Sinazongwe	Southern	AZ-18	Zambezi		Kariba				Pumps	Pipeline	80	23
S- 16	Nkandabwa	O-21		69	Sinazongwe	Southern	AZ-18		Nkandabwa		Dam	Weir		Pump	Canal	10	10
S- 17	Siazwinda	O-15		69	Sinazongwe	Southern	AZ-18	Zambezi		Kariba				Pumps	Pipeline/ Canal	80	18
S- 18	Mulumbi	O-24		71	Mansa	Luapula	AP-2		Chisenshi			Weir		Gravity	Canal	20	10
S- 19	Chembe Vegetable Scheme	N-7		71	Mansa	Luapula	AP-3	Luapula						Pump		10	0
S- 20	Mansa Pilot Scheme	I-2		71	Mansa	Luapula	AP-3		Mansa							10	0
S- 21	Kenani Vegetable Scheme	N-5		72	Nchelenge	Luapula	AP-6		Kenani		Dam					8	0
S- 22	Chama Vegetable Scheme	N-8		73	Kawambwa	Luapula	AP-4		Pambashe					Pump		10	0
S- 23	Kazembe	I-4		73	Kawambwa	Luapula	AP-6										0
S- 24	Chipesa Mubende Scheme	N-6		74	Mwense	Luapula	AP-3	Luapula						Pump		10	0
S- 25	Kantanshi Coffee Scheme	I-3		74	Mwense	Luapula	AP-3		Lucongo								0
S- 26	Lukulu	O-25	*	81	Kasama	Northern	AC-2		Lukulu			Weir		Gravity	Canal	1,000	11
S- 27	Lukuga	O-29		91	Chipata	Eastern	AL-1		Lukuga		Dam			Gravity	Canal	10	0
S- 28	Makungwa	O-28		91	Chipata	Eastern	AL-1		Makungwa		Dam			Pumps	Canal	5	5
S- 29	Vuu	O-30		93	Lundazi	Eastern	AL-1		o		Dam/ Siphon			Gravity	Canal	16	3
S- 30	Mwase	N-9		93	Lundazi	Eastern	AL-1		Lundazi		Dam			Gravity			0
S- 31	Usowe	O-31		96	Petauke	Eastern	AL-2		o		Dam			Gravity	Canal	10	0
Medium Scale Schemes																4,190	1,693
M- 1	Chiawa	O-1		12	Lusaka Rural	Lusaka	AZ-20	Zambezi						Pumps	Pipeline/ Canal	40	2
M- 2	Chanjanya	O-2		12	Lusaka Rural	Lusaka	AK-11	Kafue						Pumps	Canal	1,000	200
M- 3	Nanga Farm Ltd	O-20	*	63	Mazabuka	Southern	AK-14	Kafue						Pumps	Canal	1,750	610
M- 4	Kawambwa Tea	O-22	*	73	Kawambwa	Luapula	AP-4		Luena					Pumps	Pipeline	500	453
M- 5	Mununshi Banana	O-23		73	Kawambwa	Luapula	AP-6		Mununshi					Pumps	Pipeline	100	100
M- 6	Kaweshi Coffee	O-27	*	81	Kasama	Northern	AC-2		Lukupa					Pumps	Pipeline	500	310
M- 7	Ngoli Coffee	O-26	*	81	Kasama	Northern	AC-1		Kabulukuso					Pumps	Pipeline	*1	*1
Large Scale Schemes																32,800	20,300
L- 1	Mastock	O-3		13	(Chirundu) Lusaka Rural	Lusaka	AK-15	Kafue						Pumps	Pipeline	3,000	2,000
L- 2	Mpongwe Development Company (MDC)	O-6	*	22	Ndola Rural	Copperbelt	AK-5						G.Water	Boreholes/ Sinkholes	Pipeline/ Canal/ Booster	3,500	1,300
L- 3	Munkumpu (Schanga) Project	O-7		22	Ndola Rural	Copperbelt	AK-5		Lupala		Dam			Gravity	Pumps at Field Level	5,000	3,000
L- 4	Kaleya Smallholders Company (KSHC)	O-13	*	63	Mazabuka	Southern	AK-14	Kafue						Pumps	Pipeline/ Canal	2,200	1,900
L- 5	Nakambala Sugar Estate	O-18	*	63	Mazabuka	Southern	AK-14	Kafue						Pumps	Pipeline/ Canal/ Booster	17,000	10,000
L- 6	Gwembe Development Company	O-19		69	Sinazongwe	Southern	AZ-18	Zambezi		Kariba				Pumps	Pipeline/ Canal/ Booster	2,100	2,100
Total																38,948	22,202

(Data Source)
Land Husbandry Section, DOA, MAFF
Current Water Survey

(Notes)
O: Operational Scheme, N: Non-operational Scheme, I: Under implementation
*: Current Water Survey was conducted

Table 1-10 List of Irrigated Crops in the GRZ Irrigation Project

Project Category / Project Name		Acreage (ha) Future	Present	Status of Operation	Irrigation Method	Irrigated Crops: Wheat	Rice	Vegetable	Citrus	Pineapp	Banana	Coffee	Tea	Cotton	Sugarcane	Flowers
Small Holders Schemes		**1,958**	**209**			**19**	**0**	**65**	**12**	**9**	**53**	**14**	**0**	**0**	**0**	**0**
S- 1	Kanakantapa	30	30	Operational	Furrow											
S- 2	Chipapa	10	0	Non												
S- 3	Katunga	100	20	Operational	Surface	10		10								
S- 4	Mwaiti Farm Institute *	1	1	Operational												
S- 5	Ipafu *	80	0	Under Rehabilitation	Surface			0								
S- 6	Chapula *	60	0	Non	Surface			0								
S- 7	Mutaibaule *	8	8	Operational	Surface			8								
S- 8	Ikelenge	300	10	Just operated	Surface					5		5				
S- 9	Namushakende	7	7	Operational												
S- 10	Nakatoya	10	0	Non												
S- 11	Kafwambila	0	0	Non												
S- 12	Lusitu	13	13	Operational	Surface						13					
S- 13	Zambezi Training Farm	40	40	Operational	Furrow						40					
S- 14	Chiyabi	10	0	Non	Surface	0		0								
S- 15	Buleya Mafuna	80	23	Operational	Surface			12	12							
S- 16	Nkandabwe	10	10	Operational	Surface			10								
S- 17	Siatwinda	40	18	Operational	Surface	9		9								
S- 18	Muhumbi	70	10	Under Implementation	Surface			5				5				
S- 19	Chembe Vegetable Scheme	10	0	Non												
S- 20	Mansa Pilot Scheme	10	0	Non												
S- 21	Kenani Vegetable Scheme	8	0	Non												
S- 22	Chama Vegetable Scheme	10	0	Non												
S- 23	Kazembe	0	0	Non												
S- 24	Chipesa Mubende Scheme	10	0	Non												
S- 25	Kamani Coffee Scheme	0	0	Non												
S- 26	Lukulu *	1,000	11	Operational	Surface			4		4		4				
S- 27	Lukuzye	10	0	Operational	Surface			0								
S- 28	Makungwa	5	5	Operational	Surface			5								
S- 29	Vuu	16	3	Under Rehabilitation	Surface			3								
S- 30	Mwase	0	0	Non												
S- 31	Lusowe	10	0	Operational	Surface			0								
Medium Scale Schemes		**4,190**	**1,693**			**0**	**200**	**0**	**0**	**0**	**120**	**310**	**453**	**0**	**0**	**0**
M- 1	Chiawa	40	20	Operational	Furrow						20					
M- 2	Chanyanya	1,000	200	Operational	Basin		200									
M- 3	Nanga Farm Ltd. *	1,750	610	Operational	Sprinkler, Centre Pivit, Drip											
M- 4	Kawambwa Tea *	500	453	Operational	Sprinkler								453			
M- 5	Mununshi Banana	100	100	Operational	Sprinkler						100					
M- 6	Kateshi Coffee *	800	310	Operational	Drip							310				
M- 7	Ngoli Coffee *	*1	*1	Operational	Surface							*1				
Large Scale Schemes		**31,800**	**20,500**			**5,483**	**0**	**0**	**0**	**0**	**0**	**433**	**0**	**2,050**	**11,900**	**433**
L- 1	Mastock	3,000	2,000	Operational	Centre Pivot	1,000								1,000		
L- 2	Mpongwe Development Company (MDC) *	3,500	1,300	Operational	Movable Sprinkler	433						433				433
L- 3	Mankumpu (Nchanga) Project	5,000	3,000	Operational	Centre Pivot	3,000										
L- 4	Kaleya Smallholders Company (KSHC) *	2,200	1,900	Operational	Furrow										1,900	
L- 5	Nakambala Sugar Estate *	17,000	10,000	Operational	Furrow										10,000	
L- 6	Gwembe Development Company	2,100	2,100	Operational	Centre Pivot	1,050								1,050		
Total		**39,948**	**22,202**			**5,502**	**200**	**65**	**12**	**9**	**173**	**757**	**453**	**2,050**	**11,900**	**433**

(Data Source) Land Husbandry Section, DOA, MAFF

(Notes) 1) * : by Current Water Use Survey, 2) *1 included in M-4 (Kateshi Coffe Scheme) 3) Surface Irrigation: beds for furrow and basin irrigation

Table 1-11 Construction and Operational Agencies of GRZ Irrigation Project

Project Category / Project Name	Implementation from	Implementation to	Constructed by	Owned by	Managed by	Funded by	Project Category
Small Holders Schemes							
S- 1 Kanakantapa							Smallholders
S- 2 Chipapa							Smallholders
S- 3 Kaunga	1988	1989	JICA	GRZ/ Farmers	GRZ/ Farmers	JICA	Smallholders
S- 4 Masaiti Farm Institute *							Smallholders
S- 5 Ipasu *			GRZ	GRZ/ Farmers	GRZ/ Farmers	GRZ	Smallholders
S- 6 Chapula *	1960s		GRZ				Smallholders
S- 7 Mutanbatule *	1974		GRZ	Farmers	Farmers	Farmers	Smallholders
S- 8 Bolenge	1974	1982	GRZ	GRZ	GRZ	GRZ	Smallholders
S- 9 Namushakende							Smallholders
S- 10 Nakatoya							Smallholders
S- 11 Kafwambila							Smallholders
S- 12 Lusitu	1960s		GRZ	GRZ / Farmers	GRZ / Farmers	GRZ	Smallholders
S- 13 Zambezi Training Farm	1970s		Catholic Church	Catholic Church	Farmers	Farmers	Smallholders
S- 14 Chiyabi	1974		GRZ/ FAO	GRZ	GRZ	GRZ/ FAO	Smallholders
S- 15 Buleya Malina			GRZ	GRZ/ Farmers	GRZ/ Farmers	GRZ	Smallholders
S- 16 Nkandabwe	1960s		GRZ	Farmers	Farmers	Farmers	Smallholders
S- 17 Siatwinda	1960s		GRZ	Farmers	Farmers	GRZ/ Farmers	Smallholders
S- 18 Mulumbi	1974		GRZ	GRZ		GRZ	Smallholders
S- 19 Chembe Vegetable Scheme							Smallholders
S- 20 Mansa Pilot Scheme							Smallholders
S- 21 Kenani Vegetable Scheme							Smallholders
S- 22 Chama Vegetable Scheme							Smallholders
S- 23 Kazembe							Smallholders
S- 24 Chiposa Mubende Scheme							Smallholders
S- 25 Kamani Coffee Scheme							Smallholders
S- 26 Lukulu *	1974	1990	GRZ	Farmers	Farmers	GRZ	Smallholders
S- 27 Lukuzye	1970s		GRZ	Farmers	Farmers	Farmers	Smallholders
S- 28 Makungwa	1960s		GRZ	Farmers	Farmers	Farmers	Smallholders
S- 29 Vuu	1960s		GRZ	Farmers	Farmers	Farmers	Smallholders
S- 30 Mwase							Smallholders
S- 31 Lusowe	1960s		GRZ	GRZ		GRZ	Smallholders
Medium Scale Schemes							
M- 1 Chiawa	1970s		GRZ	LCU	LCU	LCU	Private
M- 2 Chanyanya	1980s		ZNS	ZNS	ZNS	ZNS	Parastatal
M- 3 Nanga Farm Ltd *							
M- 4 Kawambwa Tea *	1970s		GRZ	Kawambwa Tea Co.	Kawambwa Tea Co.	ZIMCO	Parastatal
M- 5 Mununshi Banana	1970s		GRZ	Kawambwa Tea Co.	Kawambwa Tea Co.	ZIMCO	Medium Scale
M- 6 Kateshi Coffee *	1970s		GRZ	ZCC	ZCC	ZIMCO	Medium Scale
M- 7 Ngoli Coffee *	1970s		GRZ	ZCC	ZCC	ZIMCO	Medium Scale
Large Scale Schemes							
L- 1 Mastock	1989		Private	Mastock	Mastock	Mastock	Large Scale
L- 2 Mpongwe Development Company (MDC) *	late 1970s	1983	MDC	ZIMCO, CDC	CDC	ZIMCO, CDC	Semi- Parastatal
L- 3 Munkumpu (Nchanga) Project	1987		ZCCM	ZCCM	ZCCM	ZCCM	Parastatal
L- 4 Kafeya Smallholders Company (KSHC) *	1970s		GRZ/CDC	Farmers/ Banks	GRZ/ KSHC	Farmers, Banks, ZSC	Smallholders
L- 5 Nakambala Sugar Estate *	1964		Tate & Lyle	ZSC	Booker Tate	ZSC	Parastatal
L- 6 Gwembe Development Company	1989		Private	Private	Private	Private	Large Scale

(Data Source) Land Husbandry Section, DOA, MAFF (*: depending Current Water Use Survey)

(Notes) 1) All projects constructed by GRZ in late 1960s - 70s were constructed by a government agency called as the Project Division under the Ministry of Rural Development.

2) Record of construction cost is not kept in the MAFF, because of administrative re-arrangement of Ministry.

GRZ: Government of the Republic of Zambia
KSHC: Kafeya Smallholders Company
ZCC: Zambia Coffee Company
ZIMCO: Zambia Industrial and Mining Co-operation
CDC: Commonwealth Development Co-operation
LCU: Lusaka Cooperative Union
ZNS: Zambia National Service
ZSC: Zambia Sugar Co-operation

1.1.3 Irrigated Commercial Farms

The Study carried out a questionnaire survey in July 1994 of the 444 irrigated commercial farms which grow wheat, rice, sugarcane or other crops requiring irrigation and which account for all irrigated farmers in Zambia National Farmers Union (ZNFU). 111 answers were collected. The membership of ZNFU consists of 1,424 farmers, accounting for most commercial farmers in the country. As shown in Table 1-12, Lusaka Province has the largest membership of 298, followed by Southern and Central Provinces with 294 and 289 members respectively. These three provinces share 60% of the total membership of ZNFU. The lowest membership is 16 in Western Province, followed by Northern and North-western Provinces, and these three provinces share only 7% of the total.

Out of 1,424 member farms, 444 farms are irrigated, equivalent to 31.2% of the total. In Lusaka Province, irrigated farms account for more than 50%, followed by Copperbelt and Central Provinces where irrigated farms account for more than 30%. Irrigated farms do not necessarily mean fully irrigated, but most of them are partly irrigated. There are very few irrigated farms in Eastern Province where the share is only 5%, followed by 6% in Western Province.

Table 1-12 Membership of ZNFU and Irrigated Commercial Farms by Province

Province	No. of Members	Irrigated Members	Distribution (%)	Irrigated Rate	No. of Answers	Collected Rate (%)
Lusaka	298	156	35.1	52.3	33	21.2
Copperbelt	154	59	13.3	38.3	10	16.9
Central	289	93	20.9	32.2	30	32.3
N/western	42	6	1.4	14.3	1	16.7
Western	16	1	0.2	6.3	0	0.0
Southern	294	81	18.2	27.6	27	33.3
Luapula	165	30	6.8	18.2	5	16.7
Northern	39	11	2.5	28.2	5	45.5
Eastern	127	7	1.6	5.5	0	0.0
Total	1,424	444	100.0	31.2	111	25.0

(Note) Number of members are based on the membership list of ZNFU in 1993

Irrigated acreage is computed based on the replies from 111 farms, which correspond to 25% of total irrigated farms of 444. The results are summarised below. Total irrigated area of all commercial farms is estimated at around 30,000 ha in 1994, based on 7,506 ha irrigated in dry season by 111 farms (25% of total commercial irrigated farms). The estimation is almost same as estimation by the water right, that is 30,820 ha. Therefore, the result of water right survey acreage is considered to be irrigation area as of 1993 to 1994. In the same manner, acreage of irrigated crops is estimated as shown in Table 1-13.

Table 1-13 Irrigated Areas and Irrigated Crops by Commercial Farms

(Unit: ha.)

Irrigated Crops	111 Farms (25%)	Total Estimated
Wheat	4,276	17,100
Orchards	1,175	4,700
Sugarcane	882	3,500
Vegetables	546	2,200
Export Crops	318	1,300
Others	309	1,200
Total Irrigated	7,506	30,000

1.1.4 Water Right and Irrigated Area

All national water rights are collected, and water rights concerned to agriculture have been selected and arranged in district basis and river basins (Supporting Report G). There are 1,359 water rights totally on agricultural purposes in the country, of which all water rights are including irrigation. Total issued water amount is 3,438,500 m3/day or about 40 m3/s and issued irrigated area is 174,100 ha in Zambia. Actual cropped area is reported as 78,700 ha out of 174,100 ha. However, water amount is too small comparing to irrigated area. The reason is that the issued irrigated area includes large portion of rainy season crops. Therefore, irrigated area is estimated only by dry season crops issued in the water right. The dry season irrigated area under water right is estimated at 53,000 ha in 1994. Remaining 25,700 ha of 78,700 ha is supplemental irrigation in rainy season. In case including fish pond of 1,660 ha into irrigation acreage, total irrigation area becomes 54,660 ha. The present status of water right is summarised as shown in Table 1-14 and 1-15 in provincial basis and in river basin block basis.

Table 1-14 Water Right of Irrigation by District and Province (1/2)

	District	Issued Water Right			Actual Irrigated Area			Irrigation in Dry Season (ha) (*)	Irrigated Crops and Irrigated Area (ha)								
		Number of Water Right	Amount (m3/day)	Irrigated Area (ha)	Total (ha)	Cropped (ha)	Fish Pond (ha)		Maize (01)	Wheat (02)(*)	Sorghum (03)	Rice (04)	Cassava (05)	Sun flower (06)	Millet (07)	Tobacco (08)	Sugar cane (09)(*)
11	Lusaka Urban	68	59,688	2,163	2,140	2,139	1	939	332	549	0	0	0	2	0	0	0
12	Lusaka Rural	115	233,141	27,870	6,847	6,845	2	4,715	596	2,778	0	0	0	8	0	94	0
13	Luangwa	2	8,456	140	20	20	0	20	0	0	0	0	0	0	0	0	0
21	Ndola Urban	54	783,379	9,909	4,518	4,312	206	3,751	255	1,717	0	0	0	0	0	6	0
22	Ndola Rural	72	61,025	3,396	1,659	1,607	52	1,096	169	249	10	1	0	0	0	1	0
23	Chililabombwe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	Chingola	27	51,542	1,780	1,746	1,746	0	925	231	338	4	0	0	10	0	50	0
25	Mufulira	15	97,068	7,447	1,006	1,006	0	634	17	0	0	2	0	0	0	0	0
26	Kalulushi	7	7,275	633	581	581	0	201	100	135	0	0	0	50	0	0	0
27	Kitwe	53	38,278	2,003	2,889	1,889	1,001	1,383	564	7	0	1	10	0	0	0	0
28	Luanshya	31	34,727	4,260	1,555	1,555	0	1,305	123	533	0	0	0	0	0	0	0
31	Kabwe Urban	11	23,389	1,053	1,513	1,513	0	901	54	289	0	0	0	0	0	0	0
32	Kabwe Rural	32	60,139	3,649	3,730	3,727	3	2,132	89	703	0	2	0	0	0	32	0
33	Mumbwa	8	420,675	21,037	2,912	2,912	0	475	2	466	0	0	0	0	0	0	0
34	Mkushi	87	149,141	6,258	5,965	5,964	1	2,893	348	1,127	0	22	0	0	0	98	0
35	Serenje	19	15,106	468	263	263	0	124	58	9	0	3	0	0	0	1	0
41	Solwezi	12	19,450	583	578	576	3	436	25	0	0	2	0	0	0	0	0
42	Mwinilunga	7	3,987	289	164	164	0	46	5	0	0	0	0	0	0	0	0
43	Zambezi	1	60	2	2	2	0	2	0	0	0	0	0	0	0	0	0
44	Kabompo	2	150	6	6	6	0	6	0	0	0	0	0	0	0	0	0
45	Mufumbwe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46	Kasempa	7	4,050	78	72	72	0	33	1	0	0	1	0	0	0	0	0
51	Mongu	1	500	30	30	30	0	0	10	0	0	5	0	0	5	0	0
52	Lukulu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53	Kalabo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54	Kaoma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	Senanga	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	Sesheke	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	Livingstone	15	8,054	336	275	275	0	66	94	0	0	0	0	0	0	0	0
62	Namwala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	Mazabuka	50	802,956	50,990	20,998	20,998	0	18,420	1,402	4,229	0	0	0	0	0	0	13,000
64	Monze	5	2,705	61	141	141	0	115	3	0	0	0	0	0	0	0	0
65	Choma	19	14,376	832	700	700	0	291	46	197	0	0	0	0	0	366	0
66	Kalomo	14	9,470	648	478	478	0	336	97	189	0	0	0	0	0	52	0
67	Siavonga	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68	Gwembe	2	1,700	82	100	0	100	0	0	0	0	0	0	0	0	0	0
69	Sinazongwe	1	10,000	200	25	25	0	0	0	0	0	0	0	0	0	0	0
71	Mansa	85	49,310	2,199	1,699	1,689	11	869	347	0	0	35	0	0	0	0	0
72	Nchelenge	1	160	5	5	5	0	5	0	0	0	0	0	0	0	0	0
73	Kawambwa	25	86,832	2,094	788	788	0	623	37	0	0	0	0	0	0	0	0
74	Mwense	35	32,515	4,482	2,551	2,520	31	525	310	0	0	41	15	0	0	0	0
75	Samfya	8	3,041	238	224	224	0	126	38	0	0	30	0	0	0	0	0
81	Kasama	179	175,027	5,804	6,055	6,039	16	4,532	666	0	9	9	0	11	0	0	0
82	Kaputa	1	1,400	80	80	80	0	20	60	0	0	0	0	0	0	0	0
83	Mbala	63	42,641	1,399	1,323	1,322	2	941	236	0	0	2	0	0	0	0	0
84	Mporokoso	80	26,642	3,448	1,090	941	149	818	44	0	0	3	0	0	0	0	0
85	Luwingu	32	15,980	579	605	580	25	414	91	0	0	0	0	0	0	0	0
86	Chilubi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
87	Isoka	6	5,147	170	170	170	0	162	7	0	0	0	0	0	0	0	0
88	Chinsali	21	22,302	885	1,021	1,019	2	401	261	0	0	110	0	0	0	0	0
89	Mpika	19	26,877	5,043	2,451	2,401	50	1,855	149	0	0	2	0	0	0	0	0
91	Chipata	40	10,455	836	701	694	7	349	108	129	0	0	0	0	0	20	0
92	Chama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
93	Lundazi	4	502	24	24	24	0	20	0	0	0	0	0	0	0	5	0
94	Chadiza	8	1,138	29	27	27	0	15	0	1	0	4	0	0	0	7	0
95	Katete	8	5,700	101	100	100	0	70	4	20	0	0	0	0	0	0	0
96	Petauke	7	12,311	526	526	526	0	44	305	0	0	0	0	0	0	2	0
10	Lusaka	185	301,285	30,173	9,007	9,004	3	5,674	927	3,327	0	0	0	10	0	91	0
20	Copperbelt	259	1,073,344	29,426	13,953	12,694	1,259	9,291	1,158	2,978	14	4	10	60	0	57	0
30	Central	157	668,441	32,464	14,383	14,379	4	6,525	550	2,585	0	27	0	0	0	131	0
40	N-Western	29	27,697	957	821	819	3	522	31	0	0	3	0	0	0	0	0
50	Western	1	500	30	30	30	0	0	10	0	0	5	0	0	5	0	0
60	Southern	106	849,261	53,148	22,717	22,617	100	19,228	1,642	4,616	0	0	0	0	0	418	13,000
70	Luapula	154	171,858	9,018	5,267	5,225	42	2,138	732	0	0	106	15	0	0	0	0
80	Northern	401	316,021	17,408	12,794	12,550	244	9,143	1,514	0	9	126	0	11	0	0	0
90	Eastern	67	30,106	1,515	1,377	1,370	7	397	416	150	0	4	0	0	0	33	0
Zambia		1,359	3,438,513	174,139	80,348	78,688	1,660	53,020	6,980	13,656	23	274	25	81	5	732	13,000

(Note) 1) : (*) counted as irrigated crops in dry season, 2) : Acreage of wheat is adjusted to MAFF statistics.
3) : Acreage of sugarcane is neglected other than Mazabuka, because of negligible small acreage.

Table 1-14 Water Right of Irrigation by District and Province (2/2)

	District	Irrigated Crops and Irrigated Area (ha)													
		Coffee (10) (*)	Tea (11) (*)	Ground nuts (12)	Soy beans (13)	Other Beans (14)	Cotton (15)	Kenaf (16)	Citrus Fruits (17) (*)	Banana (18) (*)	Vegeta bles (19) (*)	Flow ers (20) (*)	Mead ow Grass (21)	Pasture Grass (22)	Others (30)
11	Lusaka Urban	2	0	0	20	7	0	0	106	17	265	1	0	523	435
12	Lusaka Rural	20	0	110	90	41	500	0	230	7	1,472	208	0	695	589
13	Luangwa	0	0	0	0	0	0	0	0	20	0	0	0	0	0
21	Ndola Urban	7	0	11	250	5	7	0	816	35	1,176	0	2	120	146
22	Ndola Rural	80	0	0	160	11	0	1	106	5	655	1	0	2	221
23	Chililabombwe	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	Chingola	245	0	0	100	120	0	0	150	0	192	0	0	224	170
25	Mufulira	205	0	200	0	8	0	0	250	0	153	26	0	13	132
26	Kalulushi	0	0	0	0	0	0	0	9	5	52	0	0	260	5
27	Kitwe	110	0	0	0	0	0	0	260	1	997	9	0	149	81
28	Luanshya	410	0	0	2	1	0	0	93	0	269	0	0	156	106
31	Kabwe Urban	0	0	0	0	0	15	0	9	0	612	0	0	200	21
32	Kabwe Rural	0	0	0	170	42	0	0	843	0	587	0	0	30	423
33	Mumbwa	0	0	100	0	300	1,500	0	0	0	9	0	0	0	2
34	Mkushi	338	0	120	545	100	10	0	427	13	989	0	15	235	285
35	Serenje	11	0	0	0	11	0	0	37	0	67	0	0	0	47
41	Solwezi	211	0	0	0	0	0	0	5	6	214	0	0	0	101
42	Mwinilunga	0	0	0	40	10	0	0	21	1	24	0	0	45	18
43	Zambezi	0	0	0	0	0	0	0	1	0	1	0	0	0	0
44	Kabompo	0	0	0	0	0	0	0	0	0	6	0	0	0	0
45	Mufumbwe	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46	Kasempa	4	0	0	0	10	0	0	15	3	11	0	0	0	6
51	Mongu	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52	Lukulu	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53	Kalabo	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54	Kaoma	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	Senanga	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	Sesheke	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	Livingstone	0	0	0	0	0	0	0	2	0	64	0	0	105	10
62	Namwala	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	Mazabuka	480	0	0	1,040	420	220	0	304	72	335	0	0	270	335
64	Monze	0	0	0	0	0	0	0	104	0	11	0	0	0	23
65	Choma	5	0	0	40	0	2	0	16	0	73	0	0	22	6
66	Kalomo	0	0	0	0	0	0	0	36	0	111	0	28	10	25
67	Siavonga	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68	Gwembe	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	Sinazongwe	0	0	25	0	0	0	0	0	0	0	0	0	0	0
71	Mansa	307	0	0	0	33	0	0	158	48	344	3	0	101	146
72	Nchelenge	0	0	0	0	0	0	0	2	0	3	0	0	0	0
73	Kawambwa	16	140	3	3	1	0	0	256	63	148	0	0	0	117
74	Mwense	80	0	35	5	0	0	0	94	177	174	0	0	1,399	121
75	Samfya	0	0	0	0	0	0	0	68	32	26	0	0	0	17
81	Kasama	2,558	0	34	0	57	2	0	790	249	935	1	0	20	436
82	Kaputa	10	0	0	0	0	0	0	0	5	5	0	0	0	0
83	Mbala	499	0	0	0	0	0	0	143	129	171	0	1	2	62
84	Mporokoso	86	0	1	0	1	0	0	338	38	357	0	0	0	49
85	Luwingu	28	0	0	0	0	0	0	150	31	206	0	0	0	48
86	Chilubi	0	0	0	0	0	0	0	0	0	0	0	0	0	0
87	Isoka	49	0	0	0	0	0	0	63	0	50	0	0	0	2
88	Chinsali	341	0	0	0	120	0	0	30	1	29	0	0	0	26
89	Mpika	73	0	0	40	160	0	0	1,118	1	664	0	0	114	29
91	Chipata	0	0	0	0	4	0	0	66	8	146	0	0	50	52
92	Chama	0	0	0	0	0	0	0	0	0	0	0	0	0	0
93	Lundazi	0	0	0	0	0	0	0	9	0	11	0	0	0	0
94	Chadiza	10	0	0	0	0	0	0	1	0	3	0	0	0	0
95	Katete	1	0	0	0	0	0	0	23	9	18	0	0	0	8
96	Petauke	0	0	0	170	4	0	0	9	0	35	0	0	0	0
10	Lusaka	22	0	110	110	48	500	0	336	44	1,736	209	0	1,218	1,025
20	Copperbelt	1,057	0	211	512	145	7	1	1,683	46	3,493	36	2	954	863
30	Central	349	0	220	715	453	1,525	0	1,315	13	2,263	0	15	465	778
40	N-Western	215	0	0	40	20	0	0	42	10	255	0	0	45	125
50	Western	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	Southern	485	0	25	1,080	420	222	0	462	72	594	0	28	407	898
70	Luapula	403	140	38	8	34	0	0	578	320	695	3	0	1,500	400
80	Northern	3,643	0	35	40	338	2	0	2,631	453	2,415	1	1	136	652
90	Eastern	11	0	0	170	8	0	0	107	17	212	0	0	50	60
Zambia		6,184	140	639	2,675	1,461	2,256	1	7,151	974	11,663	249	46	4,745	4,799

Table 1-15 Water Right by River Basin Blocks (1/2)

River Basin / Basin No	Issued Water Right			Actual Irrigated Area			Irrigation in Dry Seasin (ha) (*)	Irrigated Crops and Irrigated Area (ha)								
	Number of Water Right	Amount (m3/day)	Irrigated Area (ha)	Total (ha)	Cropped (ha)	Fish Pond (ha)		Maize (01)	Wheat (02) (*)	Sorghum (03)	Rice (04)	Cassava (05)	Sun Flower (06)	Millet (07)	Tobacco (08)	Sugar cane (09) (*)
Zambezi																
BZ-1	2	174	4	4	4	0	4	0	0	0	0	0	0	0	0	0
BZ-2	6	3,873	287	162	162	0	48	5	0	0	0	0	0	0	0	0
BZ-3	7	1,614	76	36	36	0	20	12	0	0	0	0	0	0	0	0
BZ-4	1	500	30	30	30	0	10	10	10	0	5	0	0	5	0	0
BZ-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BZ-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BZ-7	45	32,136	1,827	1,523	1,423	100	528	225	236	0	0	0	0	0	418	0
BZ-8	1	10,000	200	25	25	0	0	0	0	0	0	0	0	0	0	0
BZ-9	77	105,968	14,638	4,132	4,130	3	2,168	516	1,301	0	0	0	0	0	14	0
Kafue																
BK-1	3	3,235	111	111	111	0	111	0	0	0	0	0	0	0	0	0
BK-2	62	155,623	10,705	4,061	4,061	0	2,083	588	342	4	2	0	60	0	50	0
BK-3	67	422,347	6,941	5,251	4,250	1,001	3,650	136	1,201	0	1	10	0	0	0	0
BK-4	128	492,239	11,672	4,532	4,274	258	2,600	434	584	10	1	0	0	0	7	0
BK-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BK-6	14	24,430	736	732	729	3	454	40	262	0	0	0	0	0	0	0
BK-7	15	22,050	620	612	610	3	465	25	18	0	3	0	0	0	0	0
BK-8	4	1,450	41	38	38	0	22	1	0	0	0	0	0	0	0	0
BK-9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BK-10	169	1,368,653	76,523	27,866	27,866	0	20,082	1,843	4,297	0	0	0	10	0	80	13,000
BK-11	2	53,000	11,100	1,160	1,160	0	541	0	521	0	0	0	0	0	0	0
Luangwa																
BL-1	49	16,012	1,083	948	941	7	644	134	228	0	0	0	0	0	22	0
BL-2	11	7,361	115	113	113	0	91	8	34	0	0	0	0	0	2	0
BL-3	114	203,130	10,122	10,374	10,373	1	7,673	426	4,061	0	24	0	0	0	130	0
BL-4	7	1,980	93	89	89	0	47	15	10	0	2	0	0	0	0	0
BL-5	3	15,250	607	507	507	0	33	300	0	0	0	0	0	0	0	0
Chambeshi																
BC-1	158	139,536	5,023	4,764	4,748	16	3,282	774	270	9	111	0	5	0	0	0
BC-2	90	94,267	2,459	2,994	2,990	4	2,672	178	66	0	12	0	6	0	0	0
Luapula																
BP-1	66	47,013	6,055	3,471	3,391	80	2,504	329	50	0	32	0	0	0	0	0
BP-2	17	25,826	719	446	446	0	293	70	10	0	1	0	0	0	1	0
BP-3	102	57,195	6,065	3,729	3,688	42	1,027	645	30	0	70	15	0	0	0	0
BP-4	65	20,287	3,509	1,151	1,008	143	870	96	4	0	0	0	0	0	0	0
BP-5	28	93,827	2,112	857	857	0	706	14	69	0	6	0	0	0	0	0
Tanganyika																
BT-1	2	325	9	6	6	0	5	0	0	0	0	0	0	0	0	0
BT-2	32	17,434	622	590	590	0	368	156	48	0	1	0	0	0	0	0
Eastern Outflow																
BE-1	12	1,778	38	36	36	0	23	1	3	0	4	0	0	0	9	0
Zambezi (BZ)	139	154,265	17,061	5,911	5,809	103	2,774	768	1,547	0	5	0	0	5	432	0
Kafue (BK)	464	2,543,027	118,448	44,362	43,698	1,264	30,008	3,067	7,226	14	7	10	70	0	137	13,000
Luangwa (BL)	184	243,733	12,019	12,030	12,022	8	8,488	882	4,333	0	26	0	0	0	154	0
Chambeshi (BC)	248	233,803	7,482	7,758	7,738	20	5,954	952	336	9	123	0	11	0	0	0
Luapula (BP)	278	244,148	18,461	9,654	9,389	265	5,401	1,154	163	0	109	15	0	0	1	0
Tanganyika (BT)	34	17,759	631	595	595	0	373	156	48	0	1	0	0	0	0	0
Eastern Outflow	12	1,778	38	36	36	0	23	1	3	0	4	0	0	0	9	0
Zambia	1,359	3,438,513	174,139	80,348	78,688	1,660	53,020	6,980	13,656	23	274	25	81	5	732	13,000

(Note) 1) : (*) counted as irrigated crops in dry season, 2) : Acreage of wheat is adjusted to MAFF statistics.
3) : Acreage of sugarcane is neglected other than BK-10, because of negligible small acreage

Table 1-15 Water Right by River Basin Blocks (2/2)

River Basin	Irrigated Crops and Irrigated Area (ha)													
Basin No.	Coffee (10) (*)	Tea (11) (*)	Ground nuts (12)	Soy beans (13)	Other Beans (14)	Cotton (15)	Kenaf (16)	Citrus Fruits (17) (*)	Banana (18) (*)	Vegetables (19) (*)	Flowers (20)	Meadow Grass (21)	Pasture Grass (22)	Others (30)
Zambezi														
BZ-1	0	0	0	0	0	0	0	3	0	1	0	0	0	0
BZ-2	0	0	0	40	10	0	0	19	1	24	0	0	45	18
BZ-3	0	0	0	0	0	0	0	0	0	20	0	0	2	2
BZ-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BZ-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BZ-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BZ-7	5	0	0	40	0	2	0	54	0	234	0	28	135	39
BZ-8	0	0	25	0	0	0	0	0	0	0	0	0	0	0
BZ-9	0	0	10	100	30	15	0	175	29	458	206	0	731	497
Kafue														
BK-1	0	0	0	0	0	0	0	12	0	99	0	0	0	0
BK-2	450	0	200	100	128	0	0	424	1	840	26	0	512	321
BK-3	510	0	1	2	1	0	0	823	5	1,103	9	2	174	230
BK-4	97	0	10	410	16	7	1	425	40	1,453	1	0	238	312
BK-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BK-6	0	0	0	50	2	0	0	46	0	146	0	0	0	173
BK-7	215	0	0	0	0	0	0	5	6	221	0	0	0	102
BK-8	0	0	0	0	10	0	0	15	3	4	0	0	0	5
BK-9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BK-10	502	0	100	1,050	738	1,720	0	570	87	1,623	3	0	757	1,386
BK-11	0	0	100	0	0	500	0	0	0	20	0	0	0	0
Luangwa														
BL-1	43	0	0	0	24	0	0	152	8	213	0	0	50	54
BL-2	1	0	0	0	2	0	0	23	9	24	0	0	0	8
BL-3	338	0	120	665	140	10	0	1,233	13	2,029	0	15	465	556
BL-4	10	0	0	0	11	0	0	9	0	17	0	0	0	5
BL-5	0	0	0	120	2	0	0	7	0	27	0	0	0	0
Chambeshi														
BC-1	1,198	0	26	0	102	0	0	721	299	794	1	1	20	380
BC-2	2,110	0	9	0	6	2	0	171	45	279	0	0	0	83
Luapula														
BP-1	101	0	0	40	210	0	0	1,374	65	915	0	0	114	121
BP-2	148	0	0	0	0	0	0	42	0	93	0	0	0	82
BP-3	210	0	35	3	33	0	0	221	118	446	3	0	1,500	218
BP-4	68	20	0	0	1	0	0	408	38	332	0	0	0	31
BP-5	38	120	0	5	0	0	0	165	162	153	0	0	0	122
Tanganyika														
BT-1	1	0	0	0	0	0	0	2	2	2	0	0	0	1
BT-2	130	0	0	0	0	0	0	55	45	90	0	0	2	55
Eastern Outflow														
BE-1	10	0	0	0	0	0	0	5	0	5	0	0	0	0
Zambezi (BZ)	5	0	35	180	40	17	0	250	30	736	206	28	913	556
Kafue (BK)	1,774	0	411	1,612	895	2,227	1	2,318	142	5,510	39	2	1,681	2,529
Luangwa (BL)	392	0	120	835	178	10	0	1,423	31	2,309	0	15	515	623
Chambeshi (BC)	3,308	0	35	0	108	2	0	892	344	1,073	1	1	20	463
Luapula (BP)	565	140	38	48	244	0	0	2,209	382	1,939	3	0	1,614	574
Tanganyika (BT)	130	0	0	0	0	0	0	57	47	92	0	0	2	56
Eastern Outflow	10	0	0	0	0	0	0	5	0	5	0	0	0	0
Zambia	6,184	140	639	2,675	1,464	2,256	1	7,154	974	11,663	249	46	4,745	4,799

1.2 Irrigation Methods in Zambia

In Zambia, various irrigation methods are applied in governmental projects and commercial farms. In small holders irrigation projects, surface irrigation like as furrow and basin irrigation is commonly applied. However, in the large and medium irrigation projects and commercial farms, over-head irrigation methods are dominant than surface irrigation. In commercial farms, over-head irrigation is introduced in 70% of total irrigated farms, of which 50% are irrigated by sprinkler irrigation. However, 30% of commercial farms are introducing surface irrigation.

Irrigation Methods in Zambia

Irrigation Method	Medium and Large Project	Commercial Farms
Sprinkler	4 projects	50.0 %
Centre Pivot	3 projects	8.7
Drip	1 project	9.5
Rain Gun	0	2.4
Surface Irrigation	5 projects	29.4
Total	13 projects	100.0 %

1.3 Previous Study on Irrigation Potential

In the Action plan of Irrigation (DOA, MAFF, Oct. 1992), the report suggests the irrigation potential to be 423,000 ha according to a World Bank Study.

Table 1-16 Irrigation Potential in Zambia reported by MAFF

River Basin	Irrigation Potential (ha)		
	Existing	Additional	Total
Upper Zambezi (Basin 1,2,3)	2,000	110,000	112,000
Kafue (Basin 4)	13,000	152,000	165,000
Luangwa (Basin 5)	-	14,000	14,000
Luapula and Tanganyika (Basin 6,7)	2,000	62,000	64,000
Commercial Farms	8,000	-	8,000
Potential of Surface Flow	25,000	338000	363,000
Potential of Groundwater			60,000
Total Potential Irrigation			423,000

(Data Source) Action Plan of Irrigation (DOA, MAFF, 1992)

In Table 1-16, in terms of irrigation water of 1.0 lit/sec/ha depending on the potential acreage, irrigation water might be 152 m3/sec for the Kafue River, and 110 m3/sec for the Zambezi River. Those figures correspond almost to the regulated flow of the Itezhi-Tezhi Dam (180 m3/sec) in the Kafue river basin and to the base flow of 1/5-year drought year (132 m3/sec, September, after Kabompo Confluence) in the Zambezi river basin respectively. From this viewpoint, above potentials are evaluated as the physical potential.

1.4 Cost of Present Irrigation

(1) Water Cost of Irrigation

Water cost of irrigation is evaluated in the gross margin budget of crops by the MAFF. The MAFF estimates water cost of irrigation at K50/m3 for irrigated crops in 1994. Following crops are considered as irrigated crops in MAFF:

Starchy Crops:	Potatoes
Vegetables:	Lettuce, Cabbage, Carrots, Tomatoes, Onion
Cereals:	Wheat

(2) Field Operation Cost

Operation of furrow irrigation can be managed by one worker for 2 ha as experienced in the Nakambala Sugar Estate. The MAFF estimates a casual labour at K500/day (Sep. 1994) in the gross budget of crops.

(3) Irrigation Facility Costs

It is difficult to obtain accurate irrigation facility cost in the construction market, because there is no standardised official information. Therefore, construction cost of irrigation facility is surveyed, and results are as follows:

Obtained Construction Cost of Irrigation (as of 1995, $1.0 = L0.60 = K610)

MAFF Estimation:	
Surface irrigation :	$1,200/ha (including a small diversion weir)
Sprinkler irrigation :	$1,500/ha (")
Contractor Estimation:	
Sprinkler irrigation :	L1,500/ha or $2,500/ha (including a borehole for 1 to 10 ha)
Centre Pivot :	L 530/ha or $ 880/ha (including a borehole for over 100 ha)
Pump price:	L3,150 or $5,250 (diameter=3 inches, Q=7 to 10 lit/sec, H=60 m)

1.5 Present Rural Infrastructures related to Irrigation

There are two major bottle necks on infrastructures for irrigation development or for existing irrigated farms especially in rural and remote areas. One is a lack of rural road network and less maintenance of rural road to connect farms to main road for marketing of products and transport of input materials. This problem is rather sever for smallholders irrigation schemes and commercial farms, because it is difficult for them to invest own road system for their farming. The other neck is a lack of rural electric grid to supply electricity for rural areas. The present electric grid covers only larger towns like provincial centre cities.

Consequently, it is essential for irrigation development to improve and expand the rural road network and the rural electric network.

CHAPTER 2 IRRIGATION WATER REQUIREMENT

2.1 Rainfall and Potential Evapotranspiration

2.1.1 Agro-ecological Zones

Zambian agriculture is greatly depend on rainfall, and rainfed agriculture is widely practised across the whole country. Consequently, the agriculture is planned by the expected amount of rain. Therefore, the agriculture of Zambia can be clearly divided into three agro-ecological zones depending on the amount of annual rainfall as summarised in the following table . Range and climatic conditions of the agro-ecological zones are detailed in Supporting Report- H.

Agro-ecological Zones of Zambia

Agro-ecological Zones	Annual Rainfall (mm)	Approximate Extension of Zone
Zone-III	1,000 - 1,400	North-Western, Copperbelt, Luapula and Northern Province, and northern part of Central Province
Zone-II	800 - 1,000	Northern half of Western and Southern Provinces, Almost all of Central Province, western part of Lusaka Province, and Eastern Province except narrow band of Zone-I
Zone-I	700 - 800	Southern half of Western and Southern Provinces, Eastern half of Lusaka Province, and narrow band along the Luangwa River in Eastern Province

2.1.2 Meteorological Stations used in the Study

Rainfall and potential evapotranspiration are the essential elements for irrigation. For studying rainfall and potential evapotranspiration, 42 meteorological stations are selected in the country. Selected meteorological stations are five stations in Agro-ecological Zone-I, 21 stations in Zone-II, and 16 stations. (see details in Table 2-5)

2.1.3 Rainfall

Rainfalls are studied for the average year and the 1/5 drought year on monthly basis in each river basin block. The result of the study is shown in Table 2-4, and illustrated in Figure 2-1. As shown in Figure 2-1, rainfall is rather stable in the northern basins, while fluctuation is larger in the southern basins. Basin rainfalls are shown in Table 2-2. It shows the maximum annual rainfall is expected both in the basins at uppermost of the Zambezi River Basin (BZ-III) and in the Chambeshi-Luapula River Basin, which reaches 1,220 to 1,250 mm in a year. Minimum rainfall might be in the lower-most of the Zambezi and Kafue Rivers (BZ-I, BK-I, BL-I). Drought rainfalls of 1/5year of both maximum and minimum rainfall zone are to be 1,128 mm to 576 mm, that is about 50% of rainfall of maximum rain zone.

Taking dominant farming area into consideration, design rainfalls are set as follows:

Table 2-1 Design Rainfall applied in the Study

Descriptions	Agro-ecological Zones		
	Zone-I	Zone-II	Zone-III
Applied Basin Rainfall (Table 2-4)	Lower Zambezi (BZ-I, BK-I, BL-I)	Middle Kafue (BK-II)	Chameshi, Luapula (BC, BP, BT)
Annual Rainfall (mm)			
Average Year	710.5	866.7	1,222.8
1/5 Drought Year	576.1	733.9	1,128.0

(Note) Monthly rainfall is shown in Table 2-4.

2.1.4 Potential Evapotranspiration

Potential evapotranspiration is also studied based on the meteorological data such as temperature, humidity, wind velocity and sunshine duration using the Modified Penman Method. The results of detail computation are shown in Table 2-5. Table 2-2 shows average potential evapotranspiration of each agro-ecological zone.

According the result, Evapotranspiration reaches the maximum in October that is end of dry season of about 6 mm/day in Zone-I and Zone-II, while 5.5 mm/day in Zone-III in September. Annual total evapotranspiration is ranging from 1,510mm in Zone-III to 1,700mm in Zone-I.

Table 2-2 Potential Evapotranspiration by Agro-ecological Zone (mm/day)

Agro-eco.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Zone-III	2.8	3.7	3.7	3.9	3.9	3.7	4.0	4.7	5.5	5.4	4.6	3.7	1,509
Zone-II	3.0	3.9	4.0	4.1	3.8	3.5	3.6	4.4	5.6	5.9	5.0	4.1	1,548
Zone-I	3.9	4.6	4.5	4.4	3.9	3.5	3.6	4.7	5.9	6.2	5.7	4.9	1,697

(Note) Details are shown in Table 2-5.

2.2 Irrigation Water Requirement

2.2.1 Crop Coefficient and Irrigation Efficiency

Irrigation requirement has been estimated monthly basis based on potential evapotranspiration, crop coefficients (Kc) and 1/5-Drought Rainfall by FAO "CROPWAT" computer programme. Crop coefficients are shown in Table 2-6. Furrow or basin irrigation is considered as the most applicable method from financial and operational aspects. Taking furrow or basin irrigation into consideration, overall irrigation efficiency is assumed at 50%. For the fishery project, irrigation efficiency is also considered, and estimated at 80% taking easiness of application into consideration. Only conveyance efficiency has been considered for the fishery project.

Irrigation Efficiencies

- Conveyance Efficiency = 80%
- Application Efficiency = 60%
- Overall Efficiency = 50% (80% * 60%)
- Efficiency of Fish Pond: Overall Efficiency = 80% (Application Efficiency = 100%)

2.2.2 Irrigation Water Requirement of Crops

Based on above conditions, irrigation requirement of major irrigated crops has been estimated as shown in Table 2-3. Typical rainy season crops such as maize and groundnuts are also analysed for evaluating drought in rainy season.

Table 2-3 Water Requirement by Crops

Crops	Required Total Water Amount (m3/ha)	Peak Irrigation Requirement (lit/s/ha)	Occurrence of Peak Irrigation Requirement
Dry Season Crops			
Cabbage - Cabbage (*)	8,000 (Z3) - 12,600 (Z1)	0.89 (Z3) - 1.13 (Z1)	Oct.
Citrus (*)	11,000 (Z3) - 14,700 (Z1)	0.88 (Z3) - 0.99 (Z1)	Sep.
Onion	11,000 (Z3) - 11,900 (Z1)	1.02 (Z3) - 1.08 (Z1)	Aug.(Z3), Sep.(Z2,Z3)
Sugarcane (*)	15,700 (Z3) - 22,200 (Z1)	1.13 (Z3) - 1.26 (Z1)	Sep.
Tomato	15,900 (Z3) - 18,200 (Z1)	1.32 (Z3) - 1.47 (Z1)	Sep.
Wheat	9,900 (Z3) - 10,400 (Z1)	1.19 (Z2) - 1.29 (Z1)	Aug.
Rice (Transplanting)	20,020 (Z2)	2.85 (Z2)	Sep.
Wet Season Crops			
Rice (Direct)	12,900 (Z2)	1.34 (Z2)	May
Maize	120 (Z3) - 2,015 (Z1)		
Groundnuts	0 (Z3) - 885 (Z1)		
Fish Pond	10,300 (Z3) - 14,300 (Z1)	0.77 (Z3) - 0.88 (Z1)	Sep.

(Note) 1) Z-1, Z-2, Z-3: corresponding to the Agro-ecological Zone-I, II, III respectively.
2) Details are shown in Table 2-7, 2-8, 2-9 and 2-10.

(1) Irrigation Requirement of Dry Season Crops

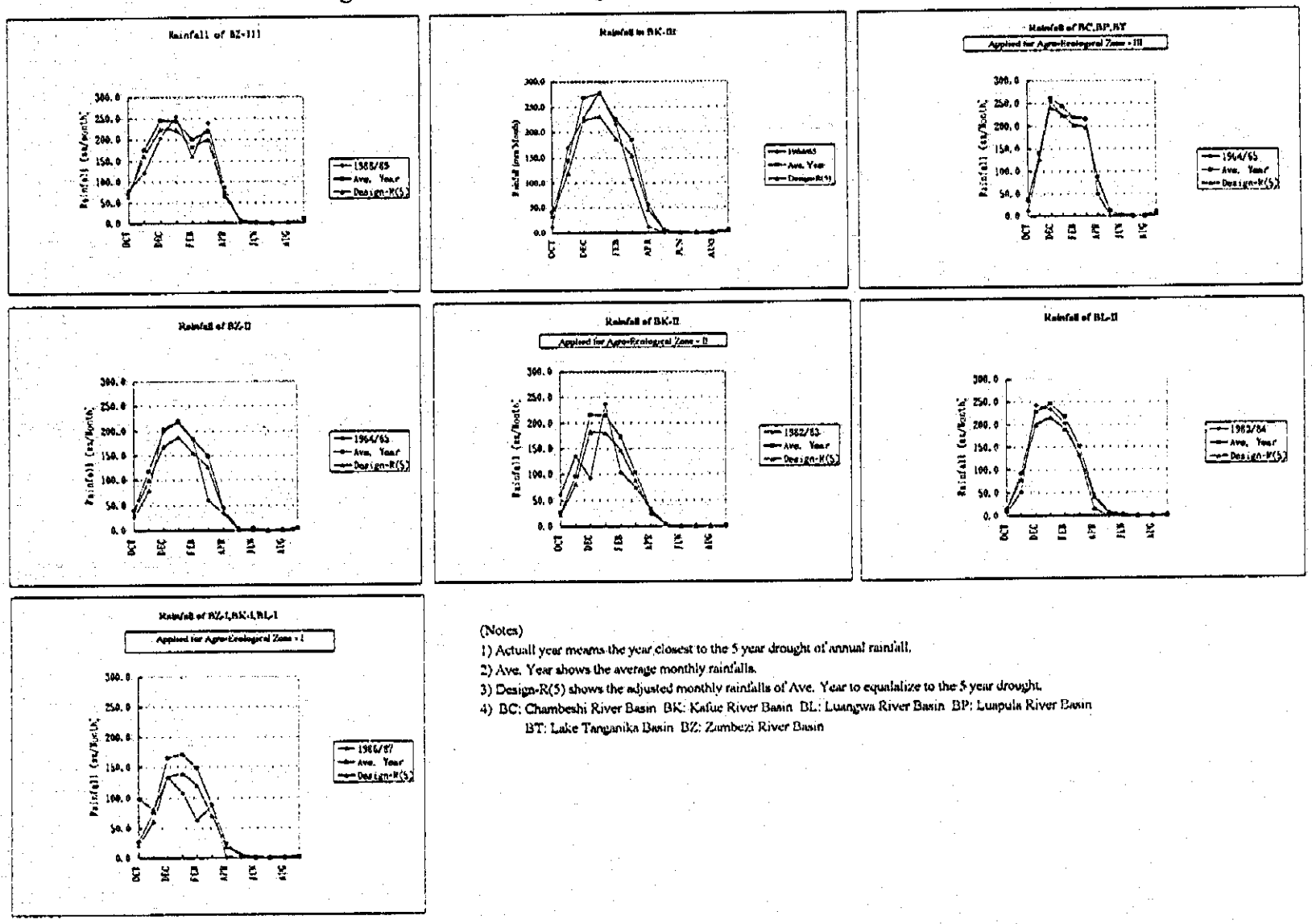
The water requirement reaches maximum generally in September, because rainfalls are very scarce and potential evapotranspiration reached maximum in September. Peak water requirements of major crops except rice are approximately 0.90 to 1.1 lit/s/ha in Zone III, and 1.1 to 1.3 lit/s/ha in 1/5year drought year. Maximum water is consumed by tomato except rice. When excluding tomato, water requirement will be 0.9 to 1.1 lit/s/ha. From above results, it is estimated for the general peak irrigation requirement as 0.95 lit/s/ha for Agro-ecological Zone-III, 1.00 lit/s/ha for Zone-II, 1.10 lit/s/ha for Zone- I , and 1.00 lit/s/ha for the national average.

(2) Irrigation Requirement of Wet Season Crops

Rainy season crops generally need less amount of irrigation water especially groundnuts. However, rice requires much amount of irrigation water of about 13,000 m3/ha even in rainy season.

Maize requires much higher amount of irrigation water than groundnuts. As studied in Table 2-9, irrigation requirement of maize concentrates on late growing period from March to April. As shown in this table, maize needs irrigation of about 100 mm to 170 mm in Agro-ecological Zone-I and Zone-II respectively. These two zones are covering the granary belt where over 80% of maize are produced in the country. Therefore, for stabilising maize production, it is essential to irrigate maize in these two zones. However, maize is seldom irrigated by in the country. The reason of it is due to less benefit for the farmers as discussed in Section 6.1.

Figure 2-1 Probable Drought Rainfalls by Agro-ecological Zones



(Notes)

1) Actuall year means the year closest to the 5 year drought of annual rainfall.
2) Ave. Year shows the average monthly rainfalls.
3) Design-R(5) shows the adjusted monthly rainfalls of Ave. Year to equalalize to the 5 year drought.
4) BC: Chambeshi River Basin BK: Kafue River Basin BL: Luangwa River Basin BP: Luapula River Basin
BT: Lake Tanganika Basin BZ: Zambezi River Basin

Table 2-4 Probable 1/5 Year Drought Rainfall by River Basins

Basin Rainfall of BZ-III

Station	Kabompo	Kasempa	Mwinilunga	Solwezi	Zambezi	Weighted							
Weight	4.95	3.01	15.90	3.91	5.63	33.40							
R(5)		1,141.1											
Actual(5)	1988.89	1,145.4											
YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Total
1988.89	80.1	122.2	204.0	253.6	158.3	238.6	86.1	0.0	0.0	0.0	0.0	2.6	1,145.5
Ave. Year	70.4	175.4	244.3	242.4	200.5	218.8	71.6	8.0	0.9	0.0	1.4	12.2	1,245.9
Design-R(5)	64.5	160.6	223.8	222.0	183.6	200.4	65.6	7.3	0.8	0.0	1.3	11.2	1,141.1

Basin Rainfall of BZ-II

Station	Kabompo	Kaoma	Kasempa	Mongu	Zambezi	Weighted							
Weight	11.44	12.90	4.62	17.44	12.13	58.53							
R(5)		818.4											
Actual(5)	1964.65	813.3											
YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Total
1964.65	26.6	78.0	205.7	217.2	182.5	59.5	33.8	0.0	6.5	0.0	0.0	3.5	813.3
Ave. Year	40.1	118.7	198.9	220.8	183.4	149.2	44.2	3.7	0.7	0.0	0.7	4.6	965.0
Design-R(5)	34.0	100.7	168.7	187.3	155.5	126.5	37.5	3.1	0.6	0.0	0.6	3.9	818.4

Basin Rainfall of BZ-I,BK-I,BL-I

Station	Choma	Livingstn	Sesheke	Weighted									
Weight	1.00	1.00	1.00	3.00									
R(5)		575.9											
Actual(5)	1986.87	573.6											
YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Total
1986.87	98.9	80.5	134.1	108.4	63.4	86.9	1.1	0.3	0.0	0.0	0.0	0.0	573.6
Ave. Year	26.9	76.1	166.0	172.1	148.5	88.6	23.8	5.0	0.6	0.1	0.5	2.3	710.5
Design-R(5)	21.8	61.7	134.6	139.5	120.4	71.8	19.3	4.1	0.5	0.1	0.4	1.9	576.1

Basin Rainfall of BL-II

Station	Chipata	Kabwe	Kasama	Lundazi	Mbala	Mpika	Mpika A	Makulu	Ndola	Petauke	Serenje	Weighted	
Weight	11.56	3.44	4.62	15.95	0.46	12.45		5.30	3.68	10.00	16.07	83.53	
R(5)		881.9											
Actual(5)	1983.84	885.7											
YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Total
1983.84	8.1	51.3	242.9	234.8	202.9	130.0	14.2	0.5	0.2	0.4	0.0	0.4	885.7
Ave. Year	14.8	91.1	228.6	246.4	217.1	151.8	45.4	6.4	2.3	0.2	0.1	1.3	1,005.5
Design-R(5)	13.0	79.9	200.5	216.1	190.4	133.1	39.8	5.6	2.0	0.2	0.1	1.1	881.8

Basin Rainfall of BK-II

Station	Choma	Kabwe	Kafue-Pld	Kaoma	Kasempa	M Makulu	Ndola	Weighted					
Weight	10.80	17.64	12.34	9.57	6.60	3.36	0.63	60.94					
R(5)		733.9											
Actual(5)	1982.83	741.0											
YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Total
1982.83	60.9	135.9	92.8	236.9	103.0	74.4	34.2	2.8	0.1	0.0	0.0	0.0	741.0
Ave. Year	26.6	96.0	216.5	214.1	173.3	103.7	29.8	4.1	0.3	0.0	0.3	2.0	866.7
Design-R(5)	22.5	81.3	183.3	181.3	146.7	87.8	25.2	3.5	0.3	0.0	0.3	1.7	733.9

Basin Rainfall of BK-III

Station	Kabwe	Kafironda	Kasempa	Ndola	Solwezi	Weighted							
Weight	3.83	11.20	7.75	4.09	9.30	36.08							
R(5)		1,005.9											
Actual(5)	1964.65	1,034.3											
YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Total
1964.65	12.1	170.6	228.2	280.2	216.4	106.7	10.8	0.1	0.9	0.0	0.0	8.2	1,034.2
Ave. Year	41.8	144.0	268.8	276.4	225.1	185.4	55.8	5.0	0.3	0.1	0.5	3.1	1,206.3
Design-R(5)	34.9	120.1	224.1	230.5	187.7	154.6	46.5	4.2	0.3	0.1	0.4	2.6	1,006.0

Basin Rainfall of BC,BP,BT

Station	Kasama	Kawambwa	Mansa	Mbala	Mpaika	Ndola	Serenje	Weighted					
Weight	25.96	21.30	19.94	17.11	12.51	1.12	8.00	105.94					
R(5)		1,127.8											
Actual(5)	1964.65	1,115.5											
YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Total
1964.65	12.5	124.3	254.4	223.7	220.0	217.0	49.3	0.1	2.1	0.0	0.0	12.1	1,115.5
Ave. Year	39.0	140.1	261.6	242.4	218.9	213.9	86.8	12.6	1.3	0.3	0.5	5.4	1,222.8
Design-R(5)	36.0	129.2	241.3	223.6	201.9	197.3	80.1	11.6	1.2	0.3	0.5	5.0	1,128.0

(Note) BC: Chambeshi River Basin BK: Kafue River Basin BL: Luangwa River Basin BP: Luapula River Basin
BT: Lake Tanganika Basin BZ: Zambezi River Basin

Table 2-5 Potential Evapotranspiration by Agro-ecological Zone and Metorological Stations

Station	Altitude (EL.m)	Potential Evapotranspiration (mm/day) Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total (mm)
Agro-ecological Zone														
Zone-III														
Zambezi	1,078	3.3	4.1	4.0	4.2	4.1	3.8	4.1	4.9	5.8	5.6	4.8	4.2	1,609
Mwinilunga	1,362	2.7	3.5	3.4	3.8	3.9	3.7	3.9	4.6	5.0	4.5	3.8	3.4	1,405
Solwezi	1,333	2.9	3.7	3.7	3.9	3.9	3.7	3.9	4.6	5.3	5.2	4.4	3.7	1,488
Kafironda	1,242	2.8	3.7	3.7	3.7	3.3	3.1	3.3	4.0	4.9	5.2	4.6	3.8	1,402
Ndola	1,270	2.9	3.7	3.9	4.3	4.2	3.9	4.8	5.4	6.6	6.0	4.8	3.9	1,656
Serenje	1,384	2.7	3.6	3.8	4.0	4.0	3.7	3.9	4.6	5.7	6.0	4.9	3.7	1,540
Kawambwa	1,324	2.7	3.5	3.5	3.9	4.0	3.8	4.2	4.8	5.2	4.8	3.7	3.4	1,445
Mansa	1,259	2.8	3.7	3.8	4.0	4.1	3.9	4.2	5.0	5.8	5.8	4.8	3.8	1,573
Samfya	1,172	2.9	3.7	3.9	4.1	4.0	3.7	3.8	4.5	5.5	5.6	4.8	3.8	1,530
Iseka	1,360	2.6	3.5	3.7	3.7	3.6	3.5	3.6	4.2	4.6	4.8	4.4	3.6	1,393
Kasama	1,384	2.8	3.6	3.7	3.9	3.9	3.8	4.0	4.7	5.6	5.4	4.6	3.8	1,515
Mbala	1,672	2.6	3.5	3.7	3.9	4.2	4.3	4.5	5.1	5.5	5.7	4.5	3.6	1,555
Mfuwe	573	3.3	4.3	4.7	4.6	4.2	3.9	4.2	5.2	6.5	7.4	6.5	4.8	1,813 *2
Misamfu	1,536	2.9	3.8	3.7	3.7	3.7	3.7	3.9	4.6	5.5	5.5	4.7	4.0	1,512
Mpika	1,402	2.6	3.5	3.7	3.8	3.8	3.6	3.7	4.6	5.6	6.0	5.1	3.6	1,509
Ave.	1,341	2.8	3.7	3.7	3.9	3.9	3.7	4.0	4.7	5.5	5.4	4.6	3.7	1,509
Zone-II														
Kafabo	1,051	3.2	4.0	4.0	3.9	3.4	3.1	3.3	3.4	4.7	4.8	4.6	4.2	1,416
Kaoma	1,152	3.1	4.0	4.2	4.1	3.6	3.3	3.6	4.4	5.4	5.4	4.6	3.9	1,508
Mongu	1,053	3.4	4.3	4.3	5.1	4.4	4.6	4.6	5.0	7.9	6.7	5.1	4.4	1,818
Kabompo	1,026	3.1	3.9	4.3	3.9	3.5	2.9	3.2	3.8	4.6	5.1	4.6	4.1	1,429
Kasempa	1,235	2.8	3.7	4.0	4.1	3.7	3.3	3.7	4.4	5.4	5.2	4.1	3.6	1,460
Lusaka C.A.	1,280	3.0	3.7	4.1	4.1	3.7	3.4	3.6	4.5	5.6	6.1	4.8	4.0	1,540
Mt. Makulu	1,213	3.3	4.1	4.1	3.9	3.7	3.3	3.7	4.8	5.7	6.3	5.4	4.2	1,597
Kabwe	1,207	3.2	4.0	4.1	4.1	3.8	3.4	3.6	4.7	5.8	6.2	5.4	4.1	1,594
Kabwe Agro.	1,165	3.6	4.2	4.2	4.6	4.5	4.4	4.9	6.1	7.6	7.7	6.1	4.3	1,893 *1
Mumbwa	1,218	3.0	3.8	4.1	4.2	3.6	3.4	2.7	3.4	4.6	6.3	5.1	4.2	1,472
Serenje	1,384	2.7	3.6	3.8	4.0	4.0	3.7	3.9	4.6	5.7	6.0	4.9	3.7	1,540
Choma	1,267	3.6	4.1	4.0	3.9	3.4	3.1	3.2	4.1	5.3	5.7	5.2	4.4	1,520
Kafue Polder	978	3.5	4.3	4.5	4.5	4.1	3.8	4.1	5.2	6.5	6.9	6.0	4.9	1,774
Magoye	1,018	3.5	4.2	4.3	4.1	3.8	3.4	3.6	4.4	5.7	6.2	5.7	4.9	1,636
Chipata	1,032	2.9	3.7	3.8	3.8	3.5	3.2	3.3	4.5	5.8	6.3	5.3	4.1	1,527
Lundazi	1,143	2.9	3.8	3.9	4.0	3.7	3.4	3.5	4.1	5.1	5.7	5.0	4.0	1,493
Msekera	1,025	2.0	3.5	3.9	4.4	4.6	4.5	4.6	5.2	6.0	5.6	4.3	3.1	1,573
Petauke	1,036	2.9	3.8	3.9	3.9	3.6	3.2	3.4	4.3	5.6	6.0	5.2	4.1	1,518
Isoka	1,360	2.6	3.5	3.7	3.7	3.6	3.5	3.6	4.2	4.6	4.8	4.4	3.6	1,393
Mpika	1,402	2.6	3.5	3.7	3.8	3.8	3.6	3.7	4.6	5.6	6.0	5.1	3.6	1,509
Ave.	1,162	3.0	3.9	4.0	4.1	3.8	3.5	3.6	4.4	5.6	5.9	5.0	4.1	1,548
Zone-I														
Senanga	1,027	3.9	4.7	4.5	4.6	4.4	4.0	4.3	5.3	6.3	6.1	5.4	5.0	1,779
Sesheke	951	4.1	5.0	4.7	4.6	3.8	3.4	3.4	4.4	5.7	6.1	6.1	5.3	1,720
Choma	1,267	3.6	4.1	4.0	3.9	3.4	3.1	3.2	4.1	5.3	5.7	5.2	4.4	1,520
Livingstone	987	3.9	4.6	4.7	4.5	4.0	3.5	3.6	4.8	6.1	6.8	6.1	5.0	1,752
Ave.	1,058 Z	3.9	4.6	4.5	4.4	3.9	3.5	3.6	4.7	5.9	6.2	5.7	4.9	1,697

(Note)
*1: excluded due to extremely high wind velocity.
*2: excluded due to lower altitude from main agricultural lands.

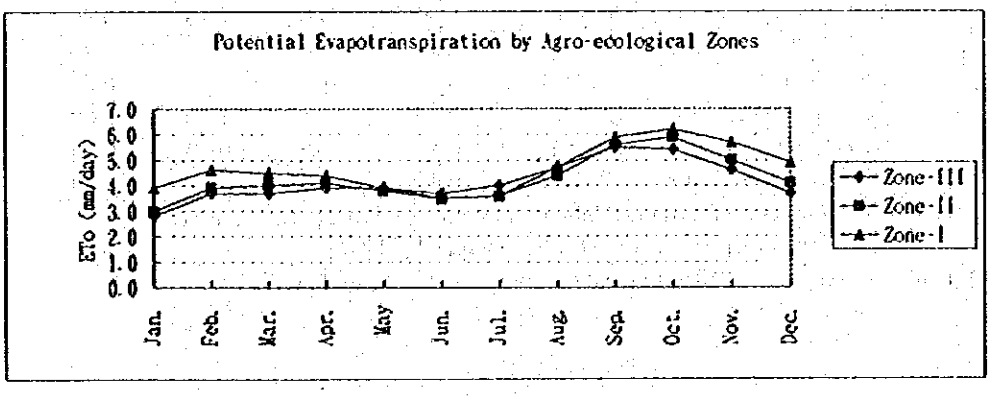


Table 2-6 Crop Coefficient and Related Coefficients applied in the Study

Crops	Ellements	(Unit)	Initial Stage	Develop ment Stage	Mid Stage	Late Stage	Total
Banana	Length Stage	(days)	90	90	90	90	360
	Crop Coefficient	(Coeff.)	0.90	--->	0.90	0.90	
	Rooting Depth	(meter)	0.80	--->	0.80	0.80	
	Depletion Level	(fract.)	0.35	--->	0.35	0.35	
	Yield-response Factor	(Coeff.)	1.30	1.30	1.30	1.30	1.30
Cabbage	Length Stage	(days)	20	40	30	10	100
	Crop Coefficient	(Coeff.)	0.70	--->	1.00	0.85	
	Rooting Depth	(meter)	0.25	--->	0.50	0.50	
	Depletion Level	(fract.)	0.40	--->	0.40	0.40	
	Yield-response Factor	(Coeff.)	0.40	0.40	0.50	0.50	0.95
Citrus	Length Stage	(days)	60	90	90	120	360
	Crop Coefficient	(Coeff.)	0.75	--->	0.65	0.75	
	Rooting Depth	(meter)	1.40	--->	1.40	1.40	
	Depletion Level	(fract.)	0.50	--->	0.50	0.50	
	Yield-response Factor	(Coeff.)	1.00	1.00	1.00	1.00	1.00
Groundnuts	Length Stage	(days)	25	25	35	25	110
	Crop Coefficient	(Coeff.)	0.55	--->	1.00	0.55	
	Rooting Depth	(meter)	0.30	--->	0.80	0.80	
	Depletion Level	(fract.)	0.45	--->	0.45	0.50	
	Yield-response Factor	(Coeff.)	0.40	0.60	0.80	0.40	0.70
Maize	Length Stage	(days)	30	40	45	30	145
	Crop Coefficient	(Coeff.)	0.45	--->	1.10	0.55	
	Rooting Depth	(meter)	0.30	--->	1.30	1.30	
	Depletion Level	(fract.)	0.50	--->	0.50	0.80	
	Yield-response Factor	(Coeff.)	0.40	0.40	1.30	0.50	1.25
Onion	Length Stage	(days)	30	50	50	30	160
	Crop Coefficient	(Coeff.)	0.70	--->	0.95	0.75	
	Rooting Depth	(meter)	0.30	--->	0.60	0.60	
	Depletion Level	(fract.)	0.30	--->	0.30	0.60	
	Yield-response Factor	(Coeff.)	0.45	0.80	0.80	0.30	1.10
Sugarcane	Length Stage	(days)	90	90	90	90	360
	Crop Coefficient	(Coeff.)	0.95	--->	0.95	0.95	
	Rooting Depth	(meter)	1.50	--->	1.50	1.50	
	Depletion Level	(fract.)	0.60	--->	0.60	0.60	
	Yield-response Factor	(Coeff.)	0.80	0.80	0.80	0.80	1.20
Tomato	Length Stage	(days)	30	40	115	30	215
	Crop Coefficient	(Coeff.)	0.70	--->	1.10	0.60	
	Rooting Depth	(meter)	0.25	--->	1.00	1.00	
	Depletion Level	(fract.)	0.30	--->	0.40	0.50	
	Yield-response Factor	(Coeff.)	0.50	0.60	1.10	0.80	1.05
Wheat	Length Stage	(days)	30	30	40	30	130
	Crop Coefficient	(Coeff.)	0.50	--->	1.20	0.60	
	Rooting Depth	(meter)	0.30	--->	1.00	1.00	
	Depletion Level	(fract.)	0.50	--->	0.50	0.70	
	Yield-response Factor	(Coeff.)	0.40	0.60	0.80	0.40	1.00

(Data Source) A computer program for irrigation planning and management. FAO (FAO Irrigation and Drainage Paper 46, 1992)

(Note) Length of stage is modified to meet cropping conditions in Zambia.

Table 2-7 Monthly Water Requirement of Major Irrigated Crops for 1/5-Drought Year

Zone	1/5-Drought Monthly Rainfall and Water Requirement (mm/month)												Water Requirement		Irrigation Requirement	
	Jan.	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total (mm)	Max. (mm/mon.)	Total (m3/ha)	Peak (lit/s/ha)
Zone-3																
1/5-Rainfall	223.6	201.9	197.3	80.1	11.6	1.2	0.3	0.5	5.0	36.0	129.2	241.3	1128.0			
Cabg+Cabg	0.0	0.0	0.0	41.0	64.3	0.0	0.0	34.1	113.9	115.6	35.0	0.0	403.9	115.6	8,078	0.89
Citrus	0.0	0.0	0.0	11.1	66.4	77.3	87.6	104.7	113.8	83.0	9.2	0.0	553.1	113.8	11,062	0.88
Onion	0.0	0.0	0.0	14.5	71.7	94.3	114.4	132.5	124.5	0.0	0.0	0.0	551.9	132.5	11,038	1.02
Sugarcane	0.0	0.0	0.0	39.3	98.5	105.5	114.9	133.3	146.3	115.7	31.2	0.0	784.7	146.3	15,694	1.13
Tomato	0.0	0.0	0.0	14.5	86.8	120.5	133.0	154.5	170.5	111.3	3.0	0.0	794.1	170.5	15,882	1.32
Wheat	0.0	0.0	0.0	0.0	35.5	72.4	140.7	163.7	82.7	0.0	0.0	0.0	495.0	163.7	9,900	1.26
Fish Pond	0.0	0.0	0.0	36.9	109.4	109.8	123.7	145.5	160.0	131.0	8.8	0.0	825.1	160	10,314	0.77
Zone-2																
1/5-Rainfall	181.3	146.7	87.8	25.2	3.5	0.3	0.0	0.3	1.7	22.5	81.3	183.3	733.9			
Cabg+Cabg	0.0	0.0	18.6	92.1	69.9	0.0	0.0	33.3	120.2	143.9	75.0	0.0	553.0	143.9	11,060	1.11
Citrus	0.0	0.0	7.6	54.2	71.9	73.8	79.9	99.2	120.0	108.2	36.2	0.0	651.0	120	13,020	0.93
Onion	0.0	0.0	0.0	44.5	77.0	89.7	104.3	125.4	130.7	0.0	0.0	0.0	571.6	130.7	11,432	1.01
Sugarcane	0.0	4.0	40.1	90.3	103.1	100.4	104.8	126.2	153.0	144.0	71.0	3.8	940.7	153	18,814	1.18
Tomato	0.0	0.0	0.0	59.9	91.5	114.5	121.3	146.2	177.7	138.9	14.0	0.0	864.0	177.7	17,280	1.37
Wheat	0.0	0.0	0.0	0.0	35.5	69.0	128.2	154.7	85.0	0.0	0.0	0.0	472.4	154.7	9,448	1.19
Fish Pond	0.0	0.0	36.2	97.8	114.5	104.7	112.0	135.7	166.3	160.5	68.7	0.0	996.4	166.3	12,455	0.8
Zone-1																
1/5-Rainfall	139.5	120.4	71.8	19.3	4.1	0.5	0.1	0.4	1.9	21.8	61.7	134.6	576.1			
Cabg+Cabg	0.0	3.3	39.8	106.2	72.7	0.0	0.0	35.3	127.8	146.5	97.6	0.0	629.2	146.5	12,584	1.13
Citrus	0.0	1.0	25.4	65.7	74.3	73.8	78.8	105.1	128.4	113.9	64.5	5.6	736.5	128.4	14,730	0.99
Onion	0.0	0.0	0.0	51.3	79.5	89.8	102.9	132.9	139.8	0.0	0.0	0.0	596.2	139.8	11,924	1.08
Sugarcane	6.2	33.8	65.9	104.5	106.5	100.5	103.4	133.8	163.7	151.5	104.1	36.3	1110.2	163.7	22,204	1.26
Tomato	0.0	0.0	0.0	71.8	94.4	114.6	119.7	155.0	190.2	146.0	20.5	0.0	912.2	190.2	18,244	1.47
Wheat	0.0	0.0	0.0	0.0	36.0	62.8	120.4	166.6	136.2	0.0	0.0	0.0	522.0	166.6	10,440	1.29
Fish Pond	0.0	8.6	68.2	112.7	116.9	104.5	111.9	145.6	175.1	170.2	109.3	17.4	1140.4	175.1	14,255	0.84

(Note)

1) Water Requirement = Crop Consumption - Effective Rainfall
2) Irrigation Requirement = Water Requirement/Irrigation Efficiency(Ie)
   Ie = 0.5 (for Crops), Ie = 0.8 (for fish pond)
3) [ ] Peak Water Requirement
4) Effective Rainfall is estimated by USDA Soil Conservation Service Method (Bureau of Reclamation Method).
   Peff = Ptot (125 - 0.2 Ptot) / 125 for Ptot < 250 mm, Peff = 125 + 0.1 Ptot for Ptot > 250 mm,
   Peff = Monthly Effective Rainfall, Ptot = Monthly Total Rainfall
5) Rainfall is applied as follows;
   Zone-1: BZ-I,BK-I,KL-I Rainfall, Zone-2: BK-II Rainfall, Zone-3: BC, BP, BT Rainfall

Table 2-8 Irrigation Requirement of Rice in Zambezi Flood Plain

Month		ET Crop /day (mm)	Loss (mm)	Days	ET Crop Month (mm)	Init. Pond (mm)	Sub Total (mm)	Precipitation (mm)	Eff. Rainfall (mm)	N.I.R. (mm)	Areal Ratio (%)	Gross I.R. (mm)	(mm)
1	*1)	2.7	2.0	31	145.7	112.5	258.2	197.8	158.2	100.0	100	117.6	
2	*1)	4.8	4.0	28	246.4	37.5	283.9	144.6	115.7	168.2	100	197.9	
3	*1)	4.8	4.0	31	272.8		272.8	160.9	128.7	144.1	100	169.5	
4	*1)	5.9	4.0	30	297.0		297.0	46.4	37.1	259.9	100	305.8	
5	*1)	5.6	4.0	31	297.6		297.6	2.0	1.6	296.0	100	348.2	Wet Season
6	*1)	2.3	2.0	30	129.0		129.0	0.0	0.0	129.0	100	151.8	1,291
7		0.0	0.0	31	0.0		0.0	0.0	0.0	0.0		0	
8	*2)	3.8	0.0	31	117.8		117.8	0.0	0.0	117.8	100	138.6	
9	*2)	10.2	7.0	30	516.0	112.5	628.5	0.0	0.0	628.5	100	739.4	
10	*2)	9.4	7.0	31	508.4	37.5	545.9	17.4	13.9	532.0	100	625.9	
11	*2)	7.9	7.0	30	447.0		447.0	53.4	42.7	404.3	100	475.6	Dry Season
12	*2)	2.6	3.5	31	189.1		189.1	193.8	155.0	34.1	100	40.1	2,020
Total				365	3,166.8			816.3	652.9	2,813.9		3,310.4	3,310

(Data Source)

The Feasibility Study on Mongu Rural Development Project
in Zambezi River Flood Plain Area, Progress Report (II), Dec, 1994, JICA

(Note)

1) *1) Transplanting Rice
2) *2) Direct Seeding Rice
3) Premises of Irrigation
   Seepage Loss: Transplanting = 4.0 mm/day, Direct Seeding = 7.0 mm/day
   Initial Ponding Water = 150 mm in total
   Effective Rainfall Rate = 0.8
   Conveyance Loss = 15 %
   Areal Ratio: Transplanting = 100%, Direct Seeding =100% (Mongu 50%)
4) Peak Irrigation Requirement
   <Wet Season Rice>: 348.2 mm/day (May)
   348.2mm/day / 30days = 11.61mm/day = 1.34 lit/sec/ha
   <Dry Season Rice>: 739.4 mm/day (September)
   739.4mm/day / 30days = 24.65 mm/day = 2.85lit./sec/ha

Table 2-9 Irrigation Requirement of Typical Rainy Season Crops

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Rainfall													
Average Year (mm)													
Zone-III	39.0	140.1	261.6	242.4	218.9	213.9	86.8	12.6	1.3	0.3	0.5	5.4	1222.8
Zone-II	26.6	96.0	216.5	214.1	173.3	103.7	29.8	4.1	0.3	0.0	0.3	2.0	866.7
Zone-I	26.9	76.1	166.0	172.1	148.5	88.6	23.8	5.0	0.6	0.1	0.5	2.3	710.5
1/5 Drought year (mm)													
Zone-III	36.0	129.2	241.3	223.6	201.9	197.3	80.1	11.6	1.2	0.3	0.5	5.0	1128.0
Zone-II	22.5	81.3	183.3	181.3	146.7	87.8	25.2	3.5	0.3	0.0	0.3	1.7	733.9
Zone-I	21.8	61.7	134.6	139.5	120.4	71.8	19.3	4.1	0.5	0.1	0.4	1.9	576.1
<Maize>													
Crop Water Requirement (mm)													
Zone-III			50.0	59.3	116.0	121.1	74.4						420.8
Zone-II			55.0	63.7	122.9	130.1	78.4						450.1
Zone-I			65.8	81.8	145.3	146.5	84.5						523.9
Irrigation Requirement													
Average Year (mm)													
Zone-III			0	0	0	0	7.6						7.6
Zone-II			0	0	7	45.8	51.6						104.4
Zone-I			0	0	35	72.2	62.6						169.8
1/5 Drought year (mm)													
Zone-III			0	0	0	0.6	11.6						12.2
Zone-II			0	0	15.4	56.3	55.7						127.4
Zone-I			0	0	50.6	84.1	66.8						201.5
<Groundnuts>													
Crop Water Requirement (mm)													
Zone-III			39.1	63.7	108.0	89.7							300.5
Zone-II			43.1	68.4	114.3	96.5							322.3
Zone-I			52.1	87.8	135.4	108.8							384.1
Irrigation Requirement													
Average Year (mm)													
Zone-III			0	0	0	0							0.0
Zone-II			0	0	1.9	12.1							14.0
Zone-I			0	0	25.1	34.5							59.6
1/5 Drought year (mm)													
Zone-III			0	0	0	0							0.0
Zone-II			0	0	7.6	22.6							30.2
Zone-I			0	1.5	40.6	46.5							88.6

(Note)

1) Computation of irrigation requirement is done by 'Cropwat' computer programme, FAO
FAO Irrigation and Drainage Paper 46

2) Effective Rainfall is estimated by USDA Soil Conservation Service Method.
(Bureau of Reclamation Method).

Peff = Ptot (125 - 0.2 Ptot) / 125 for Ptot < 250 mm, Peff = 125 + 0.1 Ptot for Ptot > 250 mm,
Peff = Monthly Effective Rainfall, Ptot = Monthly Total Rainfall

3) Crop coefficient (Kc): <Maize> Initial stage= 0.55 Mid stage= 1.00 Late stage= 0.55
<Groundnuts> Initial stage= 0.45 Mid stage= 1.10 Late stage= 0.55

4) Cropping length <Maize>= 145 days (01/December - 25/April)
<Groundnuts>= 145 days (10/December - 31/March)

Table 2-10 Potential Water Use of Fish Pond in 1/5-Drought Year

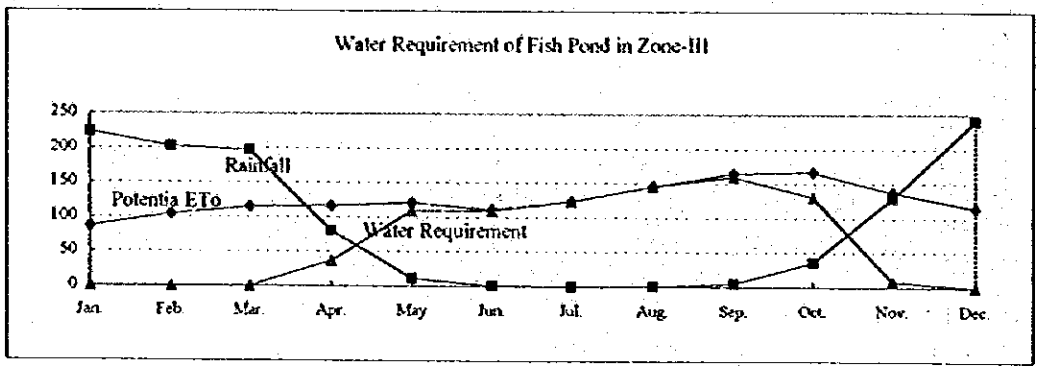
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Potential Evapotranspiration (mm/day)													
Zone-3	2.8	3.7	3.7	3.9	3.9	3.7	4.0	4.7	5.5	5.4	4.6	3.7	
Zone-2	3.0	3.9	4.0	4.1	3.8	3.5	3.6	4.4	5.6	5.9	5.0	4.1	
Zone-1	3.9	4.6	4.5	4.4	3.9	3.5	3.6	4.7	5.9	6.2	5.7	4.9	
Potential Evapotranspiration (mm/month)													
Zone-3	87	104	115	117	121	111	124	146	165	167	138	115	1,510
Zone-2	93	109	124	123	118	105	112	136	168	183	150	127	1,548
Zone-1	121	129	140	132	121	105	112	146	177	192	171	152	1,698
5-Dry Year Rainfall (mm/month)													
Zone-3	223.6	201.9	197.3	80.1	11.6	1.2	0.3	0.5	5.0	36.0	129.2	241.3	1,128.0
Zone-2	181.3	146.7	87.8	25.2	3.5	0.3	0.0	0.3	1.7	22.5	81.3	183.3	733.9
Zone-1	139.5	120.4	71.8	19.3	4.1	0.5	0.1	0.4	1.9	21.8	61.7	134.6	576.1
Water Requirement in 5-Dry Year (mm/month)													
Zone-3	0.0	0.0	0.0	36.9	109.4	109.8	123.7	145.5	160.0	131.0	8.8	0.0	825.1
Zone-2	0.0	0.0	36.2	97.8	114.5	104.7	112.0	135.7	166.3	160.5	68.7	0.0	996.4
Zone-1	0.0	8.6	68.2	112.7	116.9	104.5	111.9	145.6	175.1	170.2	109.3	17.4	1,140.4

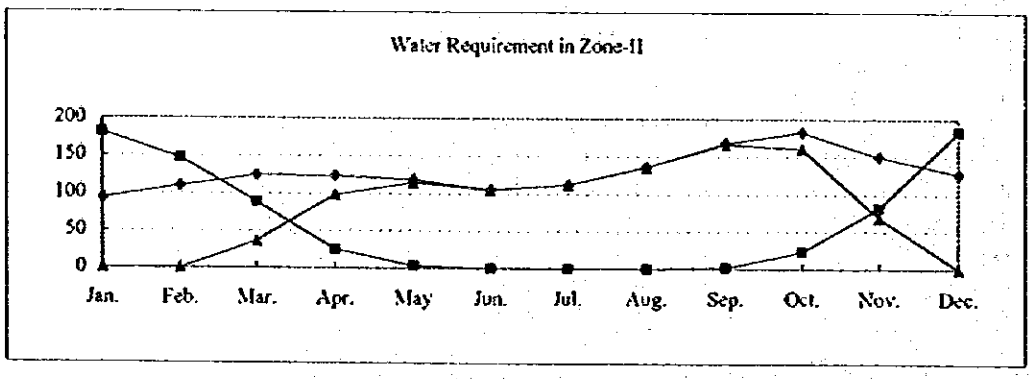
(Notes)

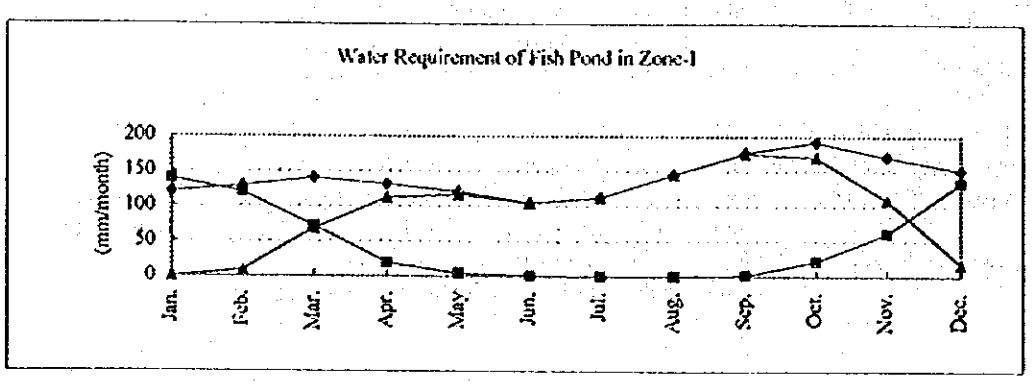
1) Evapotranspiration and Rainfall are applied as follows;
Zone-3: Chambeshi, Luapula Basin, Zone-2: Kafue-II Basin, Zone-1, Zambzi-I Basin

2) Kc value for fish pond = 1.0

3) Seepage loss is not considered in above table.







CHAPTER 3 POTENTIAL IRRIGATION AREA

3.1 Selection of Potential Irrigation Area

Irrigation potential areas have been analysed basically on the map scale of 1:250,000 with help of 1:50,000 topo-map. The criteria of selection of potential irrigation area has been set as follows:

<First Step of Selection>

1) As criteria on first selection of potential irrigation site, only water and topography were considered as limitation.
2) The site where drought flow is available and covers more than 100 ha for irrigation. For this evaluation, catchment area of all potential site is examined
3) Available drought flow Qava is defined as follows:
   Qava = Q5 - Qmin
   Q5 = Drought flow which occurs once in 5 years
   Qmin = minimum flow which occurs once in 30 years
4) The site was selected either close nor to settle of people.
5) The site was also selected either close to electricity nor .
6) The site defined on the map whether pump is required or not.
7) Existing non-operational sites are also involved as potential site, but not counted into new potential site.

<Second Screening>

Under above conditions, 93 new sites are selected on the map. Second selection has been give from soil suitability aspect. Through the second selection 93 sites are reduced to 61 sites. 32 sites are excluded from aspect of soil suitability. Including proposed dam and non-operational existing project, total potential area amounted to about 130,000 ha in total as shown in Table 4-5. This potential is quite small in acreage to compare with 423,000 ha which were previously studied. In this water resources master plan study, it is not the main subject to define the total potential of irrigation area, so that the study is not complete one for definition of irrigation potential. Smaller potential sites are still remain. If water use of irrigation is solved, much water is available in Zambezi and Kafue Rivers.

Figure 3.1 and Table 3.2 show the location and details of the potential irrigation sites.

3.2 Irrigation Potential in the Zambezi Floodplain

On the other hand, potential of Zambezi left bank floodplain is estimated at about 3,000 ha for rice cultivation according the study in the Table 3-1.

Table 3-1 Potential Acreage in the Zambezi Left Bank Plain Edge

(Limulunga - Senanga)

Crops	Litongo	Sishanjo	Sitapa	Mazulu	Total
Maize/Sorghum	1,000			1,800	2,800
Rice		415	1,265		1,680
Maize/Rice		1,525			1,525
Total	1,000	1,940	1,265	1,800	6,005

(Data Source) The Agricultural Potential of the Zambezi Floodplain and Edge. Dec. 1992 Seminar on the Agricultural Verification Study by JICA

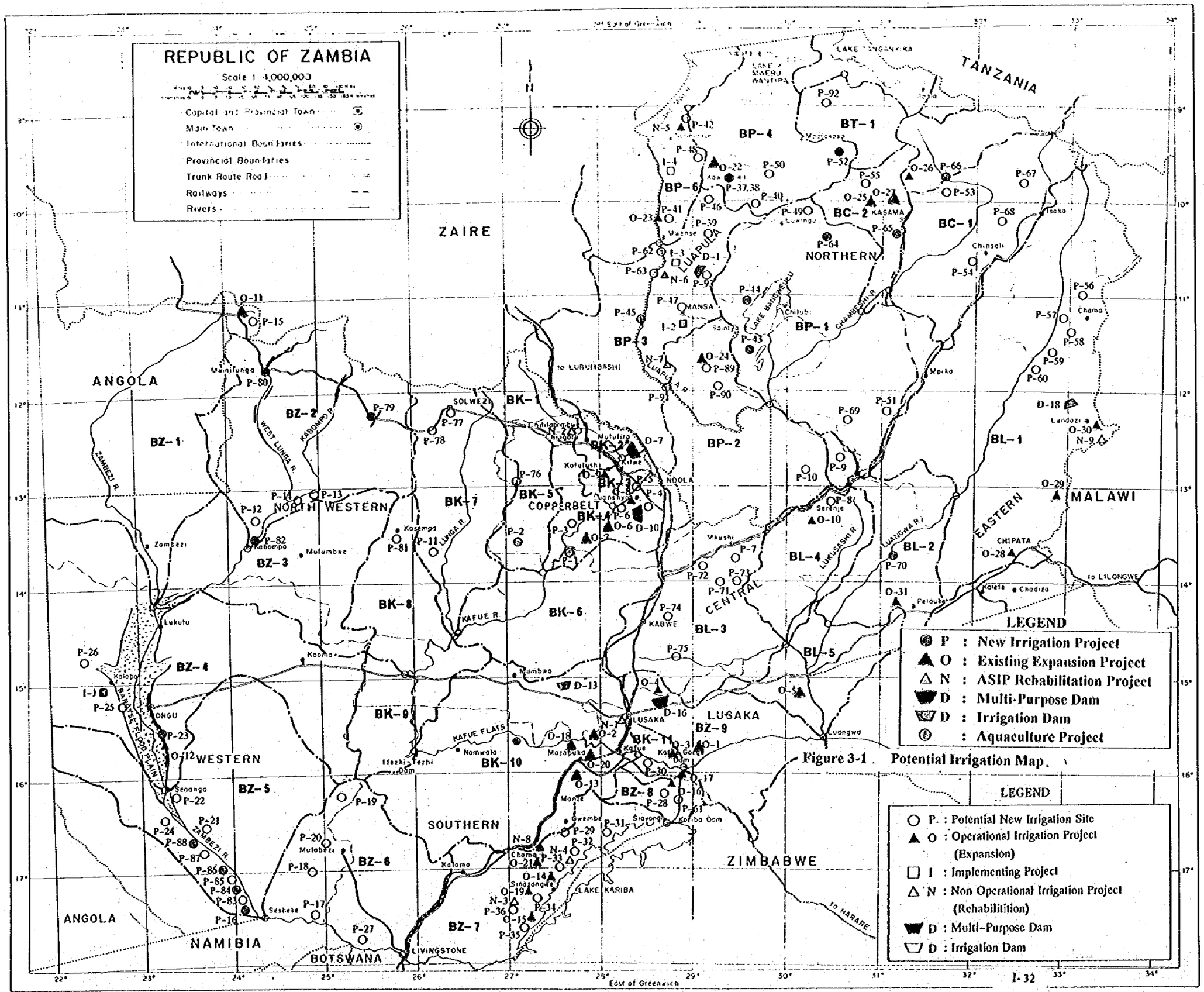


Figure 3-1 . Potential Irrigation Map.

Table 3-2 List of Irrigation Potential Area (1/3)

No.	Project or Location Name	River	River Code	Q5-Qmin (m^3/100km^2)	District	Map No. (1/250,000	Location °	'	CA (km2)	Present Land Use	Land Classificati Class	Problem	Land Availability Solutio	land (ha)	Qava (m3/sec)	Irrigable (ha)	Development Method Dam	Weir	Gravity (ha)	Pump (ha)	Booster (ha)	Furrow (ha)	Overhead (ha)	Access Elect. (km)	Road (km)	Access to Market Isk/Ndola (km)	Local Town (km)	Evaluation
Expansion of Operational Irrigation Project (Area only for Expansion)																												
O- 1	Chiawa	Zambezi	BZ	9 AZ-20	12 Lusaka Rural											20				20		20						
O- 2	Chanyanya	Kafue	BK	10 AK-14	12 Lusaka Rural											800				800		800						
O- 3	Masstock	Kafue	BK	11 AK-15	12 (Chirundu) Lusaka Rural											1,000				1,000			1,000					
O- 4	Kanakantapa	Kanakantapa	BZ	9 AZ-20	12 Lusaka Rural											0		0		0		0						
O- 5	Kaunga	Kaunga	BL	5 AL-8	13 Luangwa											80		80	80			80						
O- 6	Mpongwe Development Company		BK	4 AK-5	22 Ndola Rural							G/Water		2,200		0							2,200					
O- 7	Mankumpu Irrigation Pro	Lupala	BK	4 AK-5	22 Ndola Rural											2,000	2,000		2,000		2,000		2,000					
O- 8	Masaiti Farm Institute	Kamwense	BK	4 AK-5	22 Ndola Rural											0	0			0		0						
O- 9	Chapula	o	BK	3 AK-4	26 Kafulushi											60				60		60						
O- 10	Mutambaule	Mutambaule	BL	4 AL-5	35 Serenje											0		0	0			0						
O- 11	Ikelenge Pineapple Irriga	Sakeji	BZ	1 AZ-1	42 Mwinilunga											290		290	290			290						
O- 12	Nanushakende	Canal	BZ	4 AZ-13	51 Mongu											0			0			0						
O- 13	Kekya Small Holders Co	Kafue	BK	10 AK-14	63 Mazabuka											300				300		300						
O- 14	Buleya Malima	Kariba	BZ	7 AZ-18	69 Sinazongwe											34				34		34						
O- 15	Siatwinda	Kariba	BZ	7 AZ-18	69 Sinazongwe											4				4		4						
O- 16	Lusitu	Zambezi	BZ	8 AZ-19	67 Siavonga											0				0		0						
O- 17	Zambezi Training Farm	Zambezi	BZ	8 AZ-19	67 Chirundu											0				0		0						
O- 18	Nakambala Sugar Estates	Kafue	BK	10 AK-14	63 Mazabuka											7,000				7,000	7,000	7,000						
O- 19	Gwembe Development C	Kariba	BZ	7 AZ-18	69 Sinazongwe											0				0	0		0					
O- 20	Nanga	Kafue	BK	10 AK-14	63 Mazabuka											1,140				1,140			1,140					
O- 21	Nkandabwe	Nkandabwe	BZ	7 AZ-18	69 Sinazongwe											10	10	10		10		10						
O- 22	Kawambwa Tea Scheme	Luena	BP	4 AP-4	73 Kawambwa											47				47			47					
O- 23	Mununshi Banana Scheme	Mununshi	BP	6 AP-6	73 Kawambwa											0				0			0					
O- 24	Mufumbi Coffee Scheme	Chiwishi	BP	2 AP-2	71 Mansa											60		60	60			60						
O- 25	Lukulu North	Lukulu	BC	2 AC-2	81 Kasama											989		989	989	0		989						
O- 26	Ngoli Coffee	Kabufukuto	BC	1 AC-1	81 Kasama											included in O-27				0								
O- 27	Kateshi Coffee	Lukupa	BC	2 AC-2	81 Kasama											490				490			490					
O- 28	Makungwa	Makungwa	BL	1 AL-1	91 Chipata											0	0			0		0						
O- 29	Lukuzye	Lukuzye	BL	1 AL-1	91 Chipata											4	4			4		4						
O- 30	Vuu	o	BL	1 AL-1	93 Lundazi											10	10			10		10						
O- 31	Lusowe	o	BL	2 AL-2	96 Petauke											5	5			5		5						
Sub-Total																14,343	2,029	1,429	3,419	10,924	9,000	9,666	6,877					
Rehabilitation of Non-operational Project																												
N- 1	Chipapa		BK	10 AK-14	12 Lusak Rural											10	10		10			10						
N- 2	Ipafu	Ipafu	BK	1 AK-1	24 Chingola											80				80		80						
N- 3	Kafwambila	Zhimu	BZ	7 AZ-18	65 Choma												0		0			0						
N- 4	Chiyabi	Zambezi	BZ	7 AZ-18	68 Gwembe											10				10		10						
N- 5	Kenani Vegetable Scheme	Kenani	BP	6 AP-6	72 Nchelenge											8	8		8			8						
N- 6	Chiposa Mubende Scheme	Lunpula	BP	3 AP-3	74 Mwense											10				10		10						
N- 7	Chembe Vegetable Scheme	Luapula	BP	3 AP-3	71 Mansa											10				10		10						
N- 8	Chama Vegetable Scheme	Pambashe	BZ	7 AP-4	73 Kawambwa											10	10			10		10						
N- 9	Mwase	Lundazi	BL	1 AL-1	93 Lundazi														0			0						
Sub-Total																138	28	0	18	120	0	138						
Irrigation Project under Implementation																												
I- 1	Nakatoya	N.Luali	BZ	4 AZ-12	53 Kalabo											10												
I- 2	Mansa Pilot Scheme	Mansa	BP	3 AP-3	71 Mansa											10												
I- 3	Kanani Coffee Scheme	Luongo	BP	3 AP-3	74 Mwense																							
I- 4	Kazembe		BP	6 AP-6	73 Kawambwa																							
Sub-Total																20												
Dam Development Project																												
D- 1	Lufubu	Lufubu	BP	3	74	(23)			1,292	Shift Cul.	2			15,000	14.020	14,000	14,000		7,000	7,000		14,000				730	96	1.1
D- 2	West Lung	West Lung	BZ	2	42	6			4,651	Hill Escp	1			2,500	28.510	2,500	2,500			2,500		2,500				560	1	4.3
D- 3	Lukupa	Lukupa	BC	2	84	31			1,256	Shift Cul	3	Strogly acid			2.070	0	0											
D- 4	Kapemba	Kapemba	BL	1	92	43			403	Hill Escp	U				0.240	0	0											
D- 5	Solwezi	Solwezi	BK	8	41	14			351	Shift Cul.	1			5,000	1.020	1,000	1,000		1,000			1,000				310	1	1.1
D- 6	Kafue	Kafue	BK	2	25	19			7,549	Gov. Agr.	2			1,800	14.610	1,800	1,800			1,800		1,800				96	18	3.4
D- 7	Mutondu	Mutondu	BK	2	25	19			493	Gov. Agr.	2			5,000	1.563	1,600	1,600			1,600		1,600				90	12	1.7
D- 8	Lubi	Lubi														0	0											
D- 9	Lufupa	Lufupa	BK	8	81	15			1,038	N.R.Forst	1			14,000	0.470	500	500		500			500				430	1	3.1
D- 10	Kafubu	Kafubu	BK	4	22	20			1,017	N.R.Forst	2			8,000	4.225	4,200	4,200			4,200		4,200				48	48	1.1
D- 11	Luscmfa	Luscmfa	BL	3	34	(26)			1,473	Pre.Shift	1			5,000	4.280	4,300	4,300			4,300		4,300				210	12	1.1

Table 3-2 List of Irrigation Potential Area (2/3)

No.	Project or Location Name	River	River Code	Q5-Qmin (m^3/100km^2)	District	Map No.	Location		CA (km2)	Present Land Use	Land Classificat: Class	Land Classificat: Problem	Land Availability: Solutio	Land Availability: land (ha)	Qava (m3/sec)	Irrigable (ha)	Development Method: Dam	Weir	Gravity (ha)	Pump (ha)	Booster (ha)	Furrow (ha)	Overhead (ha)	Access: Elect. (km)	Access: Road (km)	Access to Market: Isk/Ndola (km)	Access to Market: Local Town (km)	Evaluation
D- 12	Mwonboshi	Mwonboshi	BL 3		32	(17)			1,985	Commerci	1			5,000	0.780	800	800			800		800				90	66	3.4
D- 13	Kopyonga	Kopyonga	BK 10		33	21			288	Semi-Com	1			5,000	0.370	400	400		400			400				96	60	4
D- 14	Mochito	Mochito	BK 10		12	21			40	Hill Escp	U				0.030	0	0											
D- 15	Kanakantapa	Kanakantapa	BZ 9		12	(28)			256	R.Forst	2				0.080	0	0											
D- 16	Chyongwe	Chyongwe	BZ 9		12	(28)			1,917	Semi-Com	1			5,000	0.810	800	800			800		800				48	48	1.5
D- 17	Mwapula	Mwapula	BL 3		12	(28)			398	Hill Escp	2			1,000	0.290	300	300		300			300				102	102	3.4
D- 18	Lundazi	Lundazi	BL 1		93	44			1,580	Semi-Com	1			2,000	1.480	1,500	1,500		1,500			1,500				780	24	3.4
D- 19	Lukusashi	Lukusashi	BL 4		35	33			961	Hill Escp	3	Strong clayey			5.010	0	0											
D- 20	Lutembwe	Lutembwe	BL 1		91	40			1,517	Hill Escp	1			4,000	2.760	2,800	2,800		2,800			2,800				600	36	4
D- 21	Katete	Katete	BL 1		95	41			73	Semi-Com	1			2,500	0.120	100	100		100			100				700	12	1.5
D- 22	Zambezi (Mongu)	Zambezi (Mongu)			51										0.000	0	0											
D- 23	Zambezi (Livingstone)	Zambezi (Livingstone)			61										0.000	0	0											
D- 24	Luongo	Luongo	BP 3		74	(23)			6,493	Fish Cul.	U				18.420	0	0											
D- 25	Lwombe	Lwombe	BC 4		84	31			2,580	Shift Cul.	3	Strongly acid			0.000	0	0											
D- 26	Bengwa	Bengwa	BK 10		65	22			1,677	Semi-Com	U	Utilise	Utilise	1,350	1.350	1,400	1,400		1,400			1,400				220	60	1.6
D- 27	Kalomo	Kalomo	BZ 7		66	17			1,925	Semi-Com	2			400	0.310	300	300		300			300				310	18	3.4
Sub-Total																38,300	38,300	0	35,300	23,000	0	38,300	0					
Potential Irrigation Sites																												
P- 1	Machiya	Kafue	BK 4	0.0523	32	20	13	49	24,264		2			7,600	12.690	7,600		7,600		7,600		7,600		120	1	160	90	3.4
P- 2	Luswishi	Luswishi	BK 5	0.0215	32	20			8,839		U	heavy,	Fish	1,200	1.900	1,200		1,200		1,200		1,200						
P- 3	Chisangwa	Kafue	BK 4	0.0523	22	20			20,000		U	heavy, acid		2,000	10.460	0												
P- 4	Chitwi	Chifwe	BK 4	0.0523	28	20			90		3	acid	land Improvement		0.000	0												
P- 5	Baluba	Baluba	BK 3	0.0575	28	20			210		3	acid	land Improvement		0.000	0												
P- 6	Luanshya	Luwancha	BK 4	0.0523	28	20			280		3	acid	land Improvement		0.000	0												
P- 7	Chiwefe	Munshibemba	BL 3	0.0575	34	(26)			75		1			100	0.013	40		40	40			40		10	1	220	1	1.5
P- 8	Kalwa	Kalwa	BL 4	0.017	35	33			65		2			1,800	0.011	10		10	10			10		10	1	340	1	1.1
P- 9	Katikulula	Mutemba	BP 2	0.055	35	(36)			720		2			1,000	0.396	400		400	400			400		50	10	410	96	4
P- 10	Munte	Munte	BP 2	0.055	35	(36)			640		2			500	0.352	350		350	350			350		70	12	400	60	1.1
P- 11	Kasebunga Dam	Lunga	BK 7	0.045	46	15			19,000		1			300	8.550	300		300		300		300		60	1	690	72	3.1
P- 12	Manyinga Valley	Manyinga	BZ 2	0.0547	44	8			7,500		3			500	4.103	500		500		500		500		25	1	6 0	18	1.4
P- 13	Kawama Settlement	Kabompo	BZ 2	0.0547	44	8			35,000		3			100	19.145	100		100		100		100		50	1	540	54	1.4
P- 14	Mufumbwe	Kabompo	BZ 2	0.0547	44	8			35,000		2			300	19.145	300		300		300		300		50	1	560	42	1.4
P- 15	Ikelege	Sakeji	BZ 1	0.0323	42	6			75		1			400	0.024	20		20	20			20		80	1	580	72	1.1
P- 16	Katima Mulilo	Zambezi	BZ 5	0.0338	56	12			336,953		2			1,000	113.890	1,000		1,000		1,000			1,000	1	1	620	1	1.4
P- 17	Mwandi	Zambezi	BZ 6	0.0293	56	12			513,780		2			1,000	150.538	1,000		1,000		1,000	1,000		1,000	1	1	550	72	3.4
P- 18	Luazamba	Loanja	BZ 6	0.0293	56	11			dambo		2	excessively dr		0	0.000	0												
P- 19	Bwina	Luamufoba	BZ 6	0.0293	56	11			dambo		2	excessively dr		0	0.000	0												
P- 20	Sichili	dambo	BZ 6	0.0293	56	11			dambo		2	excessively dr		0	0.000	0												
P- 21	Luanja	Zambezi	BZ 5	0.0338	55	(3)			336,053		2			1,000	113.586	1,000		1,000		1,000	1,000		1,000	1	60	880	96	1.4
P- 22	Senanga	Zambezi	BZ 5	0.0338	55	(3)			336,053		2			1,000	113.586	1,000		1,000		1,000	1,000		1,000	1	1	780	1	3.1
P- 23	Zambezi L.Foodplain	Sefula (canal)	BZ 4	0.0361	55	4			canal		2			3,000		3,000		3,000		3,000		3,000		1	1	670	18	7
P- 24	Matebele Plains	Zambezi	BZ 5	0.0338	55	(3)			336,053		3	poor drain, str		1,000	113.586	0								10	1	790	24	3.1
P- 25	Nongumba	Canal	BZ 4	0.0338	53	4			canal		2			200		200				200		200		50	1	650	130	1.4
P- 26	Ngombe	Luachi	BZ 4	0.0361	53	1			canal		2			200		200				200		200		20	1	720	90	1.4
P- 27	Zambezi Basin	Zambezi	BZ 6	0.0293	66	12			513,780		1			2,000	150.538	2,000		2,000		2,000		2,000		1	1	560	90	7
P- 28	Lusitu	Lusitu	BZ 8	?	67	28			1,600		1			500		0												
P- 29	Gwembe Escarpment	Chezya	BZ 7	?	68	22					1			3,000		0												
P- 30	Kafue Gorge	Kafue	BK 11	0.0359	63	21			156,995		U	rudie phase		3,000	87.760	0												
P- 31	Senga	L.Kariba	BZ 7	0.0851	68	22			663,880		1			2,000	564.962	2,000				2,000		2,000		125	15	180	108	4
P- 32	Chipepo	L.Kariba	BZ 7	0.0851	68	22			663,880		1			3,000	564.962	3,000				3,000		3,000		85	1	230	54	
P- 33	Chiyabi	L.Kariba	BZ 7	0.0851	68	23			663,880		1			2,000	564.962	2,000				2,000		2,000		60	1	280	90	1.4
P- 34	Sinazongwe	L.Kariba	BZ 7	0.0851	69	23			663,880		1			3,000	564.962	3,000				3,000		3,000		30	1	380	108	1.4
P- 35	Siatwinda	Zhimu	BZ 7	?	69	23			2,100		1			10,000		0												
P- 36	Kafwambila	Zhimu	BZ 7	?	66	17			930		1			5,000		0												
P- 37	Mushota Island	Lufubu	BP 4	0.17	73	25			1,400		2			2,000	2.380	Combined with P-38												
P- 38	Lucna Flats	Lufubu	BP 4	0.17	73	25			1,400		2			10,000	2.380	2,380		2,380	1,190	1,190		2,380		20	1	900	36	1.1
P- 39	Luango Valley	Luongo	BP 3	0.0705	74	(23)			1,100		1			30,000	0.776	780		780	780			780		50	13	830	72	1.1
P- 40	Lufubu Valley	Lufubu	BP 4	0.17	73	(23)			350		2			2,000	0.595	600		600	600			600		50	5	770	120	1.4
P- 41	Mununshi	Mununshi	BP 6	0.0705	74	(23)			930		2			1,000	0.656	660		660	660			660		1	1	740	60	1.3
P- 42	Nchelenge State Farm	L.Mweru	BP 6	0.0127	72	25			L.Mweru		2			1,000		1,000				1,000		1,000		1	1	880	18	1.3
P- 43	Samfya State Farm	L.Bangweulu	BP 1	0.0549	75	26			L.Bangweulu		3	strongly acid,h		500		0												
P- 44	Bangweulu West	L.Bangweulu	BP 1	0.0549	75	26			L.Bangweulu		3	poor drain,aci		5,000		0												
P- 45	Luapula Valley	Luapula	BP 3	0.0705	71	18			161,275		2			4,000	113.699	4,000				4,000		4,000		50	2	780	102	1.1

Table 3-2 List of Irrigation Potential Area (3/3)

No.	Project or Location Name	River	River Code	Q5-Qmin (m^3/100km^2)	District	Map No. (1/250,000	Location °	'	CA (km2)	Present Land Use	Land Classificati Class	Problem	Land Availability Solutio	land (ha)	Qava (m3/sec)	Irrigable (ha)	Development Method Dam	Weir	Gravity (ha)	Pump (ha)	Booster (ha)	Furrow (ha)	Overhead (ha)	Access Elect. (km)	Road (km)	Access to Market Lsk/Ndola (km)	Local Town (km)	Evaluation
P- 46	Chitundu Farm Block	Mintongwa	BP 3	0.0705	73	25			200		2			1,000	0.141	140		140	140			140		10	1	850	36	1.1
P- 47	Mansa	Mansa	BP 3	0.0705	71	26			1,470		2			5,500	1.036	1,040				1,040		1,040		1	1	710	1	1.7
P- 48	Kawambwa Tea	Mbereshi	BP 6	0.0705	73	25			140		2			100	0.099	100		100	100			100		20	1	920	30	1.1
P- 49	Chitoshi	Tete	BP 1	0.0549	84	31			8		3	strongly acid		2,000	0.004	0												
P- 50	Chiwala	Kalungwishi	BP 4	0.17	84	25			1,680		3	strongly acid		2,000	2.856	0												
P- 51	Mufubushi	Mufubushi	BP 1	0.0549	89	(36)			560		3	strongly acid		10,000	0.307	0												
P- 52	Chinakila	Lufubu	BP 4	0.17	84	30			1,000		1			6,000	1.700	1,700		1,700	1,700			1,700		50	1	840	54	1.1
P- 53	Chamfubu	Kalungu	BC 1	0.053	87	(39)			1,050		3	strongly acid		700	0.557	0												
P- 54	Lubu	Lubu	BC 1	0.053	88	(39)			1,300		3	strongly acid		450	0.689	0												
P- 55	Kapalu	Nchelenge	BC 2	0.0725	84	30			1,280		3	strongly acid		2,000	0.928	0												
P- 56	Kapilingizya	Kalinku	BL 1	0.0067	92	43			200		U	heavy		400	0.013	0												
P- 57	Katangalika	Lupamadzi	BL 1	0.0067	92	43			600		U	heavy		300	0.040	0												
P- 58	Ngonjo	Lupamadzi	BL 1	0.0067	92	43			500		U	heavy		200	0.034	0												
P- 59	Simulemba	Limunga	BL 1	0.0067	92	38			33		U	heavy		300	0.002	0												
P- 60	Chifunda	Luelo	BL 1	0.0067	92	38			450		U	heavy		200	0.030	0												
P- 61	Chitundu South	Zamberi	BZ 8	0.0847	67	28			667,970		1			1,000	565.771	1,000				1,000		1,000		55	1	130	60	3.4
P- 62	Muense South	Luapula	BP 3	0.0705	74	23			161,275		2			600	113.699	600				600		600		1	1	790	84	1.3
P- 63	Kawama South	Luapula	BP 3	0.0705	74	23			161,275		2			2,500	113.699	2,500				2,500		2,500		1	1	800	96	1.3
P- 64	Mutale Mokonge	Lubanseshi	BP 1	0.0549	81	31			1,500		3	acid			0.000	0								110	1	830	114	1.1
P- 65	Chilubula South	Lukulu	BC 2	0.0725	81	31			7,700		1			10,000	5.583	5,580		5,580		5,580		5,580		4	1	660	60	1.1
P- 66	Chamdamali	Chambeshi	BC 1	0.053	81	37			4,300		3	acid			0.000	0								80	1	780	60	1.3
P- 67	Changa Hill North	Kalungu	BC 1	0.053	87	37			2,900		1			2,000	1.537	1,540		1,540		1,540		1,540		25	1	740	54	1.1
P- 68	Chale	Lubu	BC 1	0.053	88	(39)			2,700		1			2,000	1.431	1,430		1,430	1,430			1,430		25	1	840	60	1.1
P- 69	Chiundaponde	Lulimala	BP 1	0.0549	89	(36)			700		3	acid		500	0.384	0								60	1	500	120	3.3
P- 70	Mlipwazi South	Luanguwa	BL 2	0.0103	92	33			90,560		U	heavy	as fish	10,000	9.328	9,330		9,330		9,330		9,330		125	10	410	200	3.4
P- 71	Munishiwemba	Munishiwemba	BL 3	0.0175	34	(26)			900		1			2,000	0.158	160		160	160			160		5	1	180	78	1.7
P- 72	Nkumbi Col. South	Lunsemfwa	BL 3	0.0175	34	(26)			3,200		1			2,000	0.560	560		560		560		560		4	3	170	36	1.1
P- 73	Mafila West	Mukushi	BL 3	0.0175	34	(26)			1,300		1			2,000	0.228	230		230		230		230		50	1	210	48	1.1
P- 74	Chipungu	Mafungushi	BL 3	0.0175	34	(27)			2,100		1			2,000	0.368	370		370		370		370		2	1	160	24	1.7
P- 75	Mwonboshi (D-12)	Mafungushi	BL 3	0.0175	35	(17)			1,985		1			2,000	0.347	350		350		350		350		10	10	90	72	1.6
P- 76	Lungu	Luswishi	BK 5	0.0215	22	19			2,400		1			2,000	0.516	520		520		520		520		60	1	190	84	3.4
P- 77	Solwezi	Solwezi	BK 7	0.035	41	14			1,300		1			2,000	0.585	590		590		590		590		1	1	310	1	1.1
P- 78	Misericota	Mutanda	BK 7	0.045	41	14			1,300		1			2,000	0.585	590		590	295	295		590		36	3	350	36	1.1
P- 79	Mwomboshi	Mwomboshi	BZ 2	0.0547	41	14			2,100		1			2,000	1.149	1,150		1,150		1,150		1,150		120	1	310	130	1.2
P- 80	Mwinilunga	West Lunga	BZ 2	0.0547	42	6			4,651		1			3,000	2.544	2,540		2,540		2,540		2,540		1	1	490	1	1.1
P- 81	Kasempa (D-9)	Lufupa	BK 8	0.0342	46	15			1,100		1			1,000	0.376	380		380	380			380		35	7	420	1	3.4
P- 82	Kabompo	Kabompo	BZ 2	0.0547	44	8			42,740		2	ex. dra	Overhe	5,000	23.379	5,000				5,000			5,000	10	1	670	1	1.4
P- 83	Mwanyekange Rapids	Zambezi	BZ 5	0.0215	56	42			336,053		2	ex. dra	Overhe	1,000	72.251	1,000				1,000			1,000	1	1	650	18	1.4
P- 84	Ngambwe Rapids	Zambezi	BZ 5	0.0215	56	42			336,053		2	ex. dra	Overhe	1,000	72.251	1,000				1,000			1,000	1	1	660	36	1.4
P- 85	Lusu Rapids	Zambezi	BZ 5	0.0215	56	12			336,053		2	ex. dra	Overhe	1,000	72.251	1,000				1,000			1,000	1	1	670	48	1.4
P- 86	Manto Rapids	Zambezi	BZ 5	0.0215	56	12			336,053		2	ex. dra	Overhe	1,000	72.251	1,000				1,000			1,000	1	1	680	60	1.4
P- 87	Kaole Rapids	Zambezi	BZ 5	0.0215	56	(3)			336,053		2	ex. dra	Overhe	1,000	72.251	1,000				1,000			1,000	1	1	740	114	3.4
P- 88	Sioma Rapids	Zambezi	BZ 5	0.0215	55	(3)			336,053		2	ex. dra	Overhe	1,000	72.251	1,000				1,000			1,000	1	1	780	160	1.4
P- 89	Milomo	Lwela	BP 2	0.0550	74	26			1,400		2			1,000	0.770	770		770		770		770		65	1	770	60	1.1
P- 90	Ngoniba	Mafungushi	BP 2	0.0550	71	26			770		2			500	0.424	420		420		420		420		80	1	620	66	1.1
P- 91	Chafunike	Luapula	BP 3	0.0705	71	26			161,275		2			3,500	113.699	3,500				3,500		3,500		95	1	830	120	1.1
P- 92	Musakanya	Lufubu	BT 1	0.0875	82	30			6,000		1			1,600	5.250	1,600		1,600		1,600		1,600		50	1	890	72	1.1
P- 93	Lufubu (D-1)	Lufubu	BP 3	0.0705	74	(23)			1,292	Shift Cul.	2			4,200	0.911	910		910		910		910		50	1	760	48	1.1
Sub-total																90,240												
Total																193,041												

(Note)

1) Optential areas of P-1 to P-60 reffers to the List by DOA, MAFF
2) O: Operational Schemes (Irrigable area means the area only to be expanded.), N: Non-operational Schemes, I: Implementing Schemes, D: Potential Dam Development, P: Potential Run-of-River Development
3) P-1 to P-60: Potential Areas by MAFF
4) Over P-61: Selfected by this Study
5) Development Methods: D.W: Diversion Weir, C.W: Concrete Weir, B.W: Bush Weir, P: Pump, G: Gravity, F: Furrow irrigation, B: Basin Irrigation, S: Sprinkler
6) Land Classification 1: none restrictions, 2: some restrictions, 3: restricted, U: unsuitable for cultivation.

CHAPTER 4 IRRIGATION DEVELOPMENT

4.1 Definition of Irrigation Development

4.1.1 Proposal of Long Term Agricultural Development Plan

Agricultural development plan is proposed, corresponding to the three scenarios set in the socioeconomic framework, based on the present conditions and programmes expressed in ASIP. Irrigation development plan is formulated according to the proposed agricultural development plan, as shown in Table 4-1.

Table 4-1 Agricultural Development Scenarios

	Present Status	Base Scenario - Agricultural Expansion	Base Scenario - Industrialisation	Conservative Scenario
Population (1000 persons)	7,969 (1993) (=100)	12,738 (160)	14,336 (180)	11,589 (145)
Annual Growth in Value Added of Agricultural Sector	Average 2.3% (1985-1993)	1994-2000: 6.0% afterwards: 3.0%	3.0% (constant)	1995-: 2.6% 2000-: 2.3% 2005-: 2.0% 2010-: 1.5%
value Added of Agricultural Sector - 2005 - 2015)	(299.3 billion K.) (=100)	 494.9 billion K. (165) 699.8 billion K. (234)	 439.6 billion K. (147) 616.4 billion K. (206)	 382.7 billion K. (128) 491.2 billion K. (164)

4.1.2 Proposed Irrigation Development

Required irrigation development has been examined and proposed to produce necessary value added (VA) of agricultural sector in each scenario, particularly value added of crop sub-sector. Since other sub-sectors than crops, namely livestock, fishery, wildlife and forestry are proposed to satisfy the necessary production depending on the projected population or the projected value add in each scenario, Therefore, necessary irrigation development has been studied in connection with production of rainfed crops under following premise of irrigation development.

<Premise of Irrigation Development>
Rain fed agriculture will remain predominant even in the future, and most of maize and oil crop production will be obtained through rain fed cultivation. Irrigated wheat and rice will be complementary for stable production of cereals. In addition, irrigation will support the production of cash crops, such as vegetable and fruit, and of exported goods, such as coffee, sugar and flowers, in order to contribute to the improved balance of payments of the country and high growth in the Value Added of the sector.

Under above premise of irrigation development, following conditions are set for irrigated crops:

<Cereal Crops>
Irrigated cereal crops like wheat and rice will support rainfed maize production, and to satisfy national demand of staple crop in each scenario. In this connection, wheat has been set to produce 13 kg of per capita consumption and to realise self sufficiency of wheat. On the other hand, intensive rice cultivation is proposed especially in the Zambezi Floodplain. However development of intensive rice will be limited to 3,000 ha in maximum due to limitation of flood free areas.

<Vegetables>
Vegetables are the most suitable for cash earning. Current production has reached the level to meet the supply of 65 kg/capita/year, and rapid consumption increase will not occur. Further, large scale export will be difficult. Current level of production is assumed to continue.

< Fruit >
Current consumption of fruit is 16 kg/capita/year, which corresponds to 30% of the consumption in developed countries (50 kg/capita/year). In the Base Scenario-Agricultural Expansion, where the largest increase of agricultural production is projected, production of fruit is planned to increase to meet a consumption level of 27 kg/capita/year.

< Coffee and Tea >
Coffee and tea plantation is expanding by 530 ha/year. Much endeavour is being made by entrepreneurs to marketing and exports of coffee and tea. Current expansion is assumed to continue in the Base Scenario-Agricultural Expansion. In other scenarios, however, the production will grow at the same rate as that set for growth of total value added of agricultural sector in each scenario, considering possible risks in the future.

< Sugarcane >
Sugar is ranked second of the exported agricultural products. The complete process from plantation to exporting has been established by the sugar company. The plantation will be expanded from the current area of 13,000 ha to 21,000 ha by 2005, in accordance with projection of the production expansion planned by the company.

< New Products >
Flower growing and exports have been started recently mainly by commercial farmers. ASIP highlights expansion in the future. The markets for flowers are European countries, where stable and expanded supply with lower price in winter can be achieved from Zambia which enjoys summer at the same time. Therefore, production will increase to 10 times the present level in the Base Scenario-Agricultural Expansion. In the other scenarios, the production will grow at the same rate as that of total value added of the sector of each scenario, considering possible risks.

Under above premises, proposed irrigation area has been set as shown in Table 4-2. Proposed irrigation area is at maximum in Base Scenario- Agricultural Expansion of about 61,000 ha, at 54,000 ha in Base Scenario- Industrialisation, and at minimum in Conservative Scenario of about 38,000 ha respectively. The details of this study is described in Chapter 5, Supporting Report-H.

Table 4-2 Proposed Irrigation Development by Three Scenarios

	Current Status (1993)	Base Scenario - Agricultural Expansion	Base Scenario - Industrialisation	Conservative Scenario
< Total Irrigated Area >	53,000 ha (=100)	114,000 ha (215)	107,000 ha (202)	91,000 ha (172)
<Newly Irrigated Area>	-	61,000 ha	54,000 ha	38,000 ha
(1) Cereal Crops	13,656 ha (100)	36,000 ha (264)	40,200 ha (294)	32,700 ha (239)
Wheat	13,656 ha (100)	33,200 ha (243)	37,200 ha (272)	30,200 ha (221)
Intensive Rice				
-Wet Season Rice	0 ha	2,800 ha	3,000 ha	2,500 ha
-Dry Season Rice	(0 ha)	(1,400 ha)	(1,500 ha)	(1,250 ha)
(2) Vegetables	11,663 ha (100)	19,200 ha (165)	21,500 ha (184)	17,400 ha (149)
(4) Fruits	8,128 ha (100)	16,700 ha (205)	12,000 ha (148)	9,700 ha (119)
(5) Coffee & Tea	6,300 ha (=100)	18,240 ha (290)	12,000 ha (190)	9,600 ha (152)
(6) Sugar Cane	13,000 ha (=100)	21,000 ha (162)	21,000 ha (162)	21,000 ha (162)
(7) New Crops (flower)	250 ha (=100)	2,500 ha (1000)	500 ha (200)	380 ha (152)
< Additional Irrigation Water Demand >	-	5,282,000 m^3/day	4,680,000 m^3/day	3,242,000m^3/day

(Note) 1) Acreage of wet season rice is counted in total irrigation area.
2) Water demand is estimated based on 1.00 lit./sec/ha.
3) Detail acreage of irrigation area is shown by crop basis both for 2005 and 2015 in Table 4-3.

Table 4-3 Proposed Crop Development by Three Scenarios

Crops		Actual	Base Scenario - Agricultural Expansion		Base Scenario - Industrialisation		Conservative Scenario	
			2005	2015	2005	2015	2005	2015
Maize		820,396	1,138,000	1,332,000	1,024,200	1,218,600	944,500	984,800
Sorghum		47,792	79,000	96,800	71,100	88,600	65,600	71,600
Millet		54,808	120,000	157,000	108,000	143,600	99,600	116,100
Rice (Ext.)	(*)	13,711	17,500	22,100	19,600	24,800	15,900	20,100
Rice (Int.W.S.)	*	0	1,800	2,800	2,100	3,000	1,700	2,500
Rice (Int.D.S.)	(*)	0	900	1,400	1,050	1,500	850	1,250
R. Wheat		3,686	0	0	0	0	0	0
I. Wheat	*	13,656	24,000	33,200	26,900	37,200	21,800	30,200
Cereals		954,049	1,381,200	1,645,300	1,252,950	1,517,300	1,149,950	1,226,550
Cassava		107,812	135,400	171,600	152,500	193,200	123,000	155,900
Potatoes		1,670	2,500	3,400	2,800	3,900	2,300	3,100
Starchy		109,482	137,900	175,000	155,300	197,100	125,300	159,000
Sugarcane	*	13,000	21,000	21,000	21,000	21,000	21,000	21,000
Sugar crop		13,000	21,000	21,000	21,000	21,000	21,000	21,000
M. Beans		38,489	53,800	73,200	60,600	82,400	48,900	66,500
Pulse Crops		38,489	53,800	73,200	60,600	82,400	48,900	66,500
Soybean		19,864	68,900	94,900	26,500	29,200	21,200	29,200
Groundnuts (R)		68,808	299,000	517,400	115,000	123,200	97,400	130,400
Groundnuts (I)	(*)	13,656	24,000	33,200	26,900	37,200	21,800	30,200
Sunflower		35,899	0	0	0	0	0	0
Seed Cotton		76,492	68,000	0	68,000	90,000	54,400	72,000
Oilseed Crops		214,719	459,900	645,500	236,400	279,600	194,800	261,800
Tobacco(V)		3,558	5,000	6,200	4,000	5,000	3,200	4,000
Tobacco(B)		3,388	6,900	10,000	5,600	8,100	4,500	6,500
Tobacco		6,946	11,900	16,200	9,600	13,100	7,700	10,500
Tomatoes	*	6,000	6,900	9,800	7,700	11,000	6,300	8,900
Onion	*	1,000	1,100	1,700	1,300	1,900	1,000	1,500
Cabbage	*	3,000	3,400	4,900	3,900	5,500	3,100	4,500
Lettuce	*	663	800	1,100	900	1,200	700	1,000
Carrots	*	1,000	1,100	1,700	1,300	1,900	1,000	1,500
Vegetables		11,663	13,300	19,200	15,100	21,500	12,100	17,400
Coffee	*	6,184	12,000	18,000	7,900	11,800	6,300	9,500
Tea	*	140	190	240	130	160	100	130
Stimulant Crops		6,324	12,190	18,240	8,030	11,960	6,400	9,630
Orange	*	7,154	9,700	14,600	7,000	10,500	5,700	8,500
Banana	*	974	1,500	2,100	1,100	1,500	900	1,200
Fruits		8,128	11,200	16,700	8,100	12,000	6,600	9,700
Flower	*	250	1,250	2,500	380	500	310	380
New Crops		250	1,250	2,500	380	500	310	380
Total Planted Area		1,363,050	2,103,640	2,632,840	1,767,460	2,156,460	1,573,060	1,782,460
Irrigated Area (ha)		53,021	84,740	113,640	81,610	107,160	69,910	90,810
Incremental from 1993			31,719	60,619	28,589	54,139	16,889	37,789

1) *: Irrigated Crops 2) (*) : Irrigated but not counted in irrigated area. 3) Groundnuts(I): considered as supplemental irrigation crop before planting wheat.

4.1.3 Allocation of Irrigation Area

As resulting in Table 4-2, irrigated lands are to be developed at about 61,000ha for Base Scenario-Agricultural Expansion, and 54,000ha for Base Scenario-Industrialisation and 38,000ha for Conservative Scenario respectively. On the other hand, potential irrigation areas are estimated at about 132,000ha in the country as shown in Table 3- 2. The locations of potential areas are shown in Figure 3-1. For appropriate allocation of said irrigated areas, following priorities have been considered:

< Priorities >

- Lower income regions. (Luapula, Western, North-Western, Northern)
- Lower yield region. (Western, Eastern, Lusaka, North-Western)
- Food unbalanced regions among Agriculture dominant provinces. (Western)
- High potential region on water resources. (Luapula, Southern, Central, N/Western, Northern,Western)
- Adjacent provinces to large market from Economic viewpoint (Lusaka, Copperbelt)

Based on above priorities, basic allocation ratio has been tabulated as shown in Table 4-4. This basic allocation ratio has been applied to make appropriate provincial allocation of irrigation area. The proposed allocation is shown in Table 4-5.

Table 4-4 Basic Allocation Ratio for Improvement of Farm Income Gap

Province	Equivalent Planted Area/ Household	Ratio to 3.00ha	Necessity of Development	Allocation Weight of Staple Crop	Invest Effect by Market	Adjusted Necessity of Develop.	Potential of Irrigation	Adjust. by Potential	Basic Allocation Ratio of Irrigation
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	<*1>	<*2> 3.00/(1)	1/(2)	<*3>	<*4>	(3) /(4)x(5)		(6)*(7) / Total(7)	(8) /Total(8)
	(ha)						(ha)		
Lusaka	2.73	91%	1.10	0.800	1.000	1.380	3,010	0.031	2%
Copper belt	1.96	65%	1.54	0.800	1.000	1.930	10,260	0.149	9%
Central	4.71	157%	0.64	1.000	1.000	0.640	15,570	0.075	4%
N/ Western	0.78	26%	3.85	1.000	0.500	1.930	15,260	0.222	13%
Western	0.74	25%	4.00	0.500	0.500	4.000	13,410	0.405	23%
Southern	6.42	214%	0.47	0.500	1.000	0.940	23,148	0.164	9%
Luapula	0.73	24%	4.17	1.000	0.500	2.090	33,555	0.529	30%
Northern	1.46	49%	2.04	1.000	0.500	1.020	13,829	0.106	6%
Eastern	1.92	64%	1.56	0.575	0.800	2.170	4,419	0.072	4%
Total	2.22	74%	19.37	7.175		16.100	132,461	1.753	100%

(Note)

<*1>: Equivalent farming size (see Supporting Report-H, Section 1.2.10)

<*2>: 3.00 ha = Necessary cultivation area per household from viewpoint of farm expenditure.

<*3>: assumed based on regional food balance. (Imbalance provinces are set in high priority.)

<*4>: assumed based on distance to large markets. (Adjacent provinces are set in high priority.)

Table 4-5 Provincial Allocation of Irrigation Development

Province	Lusaka	Copperbelt	Central	N/Western	Western	Southern	Luapula	Northern	Eastern
Potential Irrigable Area (ha)									
132,461	3,010	10,260	15,570	15,260	13,410	23,148	33,555	13,829	4,419
Basic Allocation Ratio									
	2%	9%	4%	13%	23%	9%	30%	6%	4%
Allocation									
61,000	1,100	5,000	3,000	8,000	14,000	6,000	18,000	4,000	3,000
Existing Irrigation Projects									
ASIP Rehabilitation Project									
267	10	140	0	0	0	89	0	0	28
Existing Expansion Project									
16,484	1,900	4,200	0	290	10	8,450	1,144	490	0
New Irrigation Projects (Base Scenario - Agricultural Expansion)									
Multipurpose Dam Project									
6,590	810	5,780	0	0	0	0	0	0	0
Irrigation Dam Project									
8,480	0	0	0	0	0	0	7,000	0	1,480
Run-of-river Project									
29,000	0	0	5,000	6,300	7,000	0	4,000	6,700	0
Total (ha) 60,821	2,720	10,120	5,000	6,590	7,010	8,539	12,144	7,190	1,508

4.1.4 Selection of Irrigation Project

(1) ASIP Rehabilitation Project and Existing Expansion Project

In selection of irrigation project, first priority has been set on the ASIP Rehabilitation Project and the Existing Expansion Project from viewpoints of quick response of effect in ASIP Rehabilitation Project and well management in the Existing Expansion Project respectively. ASIP Rehabilitation Project is composed of 9 projects which cover 267 ha. Existing Expansion Project is composed of 21 projects, which cover 16,484 ha. Outline of these two projects are as follows:

Table 4-6 Outline of ASIP Rehabilitation and Existing Expansion Projects

Province	ASIP Rehabilitation Project	Area	Existing Expansion Project	Area
Lusaka	N-01 Chipapa	10	O-01 Chiawa	20 ha
			O-02 Chanyanya	800
			O-03 Masstock	1,000
			O-05 Kaunga	80
	1 project	10	4 projects	1,900
Copperbelt	N-02 Ipafu	80	O-06 Mpongwe	2,200
	O-09 Chapula	60	O-07 Munkumpu	2,000
	2 projects	140	2 projects	4,200
N/Wester			O-01 Ikelenge Pineapple	290
			1 project	290
Western			I-11 Nakatoya	10
			1 project	10
Southern	O-14 Buleya Malima	57	N-04 Chiyabi	10
	O-15 Siatwinda	22	O-13 Kafeya Smallholders	300
	O-21 Nakandabwe	20	O-18 Nakanbala Sugar Estate	7,000
			O-20 Nanga	1,140
	3 projects	89	4 projects	8,450
Luapula			I-02 Mansa Pilot	10
			N-05 Kenani Vegetables.	8
			N-06 Chiposa Mubende State	10
			N-07 Chembe Vegetable State	10
			N-08 Chama Vegetables	10
			O-22 Kawambwa Tea	47
			O-24 Mulumbi Coffee	60
			O-25 Lukulu North	989
			8 projects	1,144
Northern			O-27 Kateshi Coffee	490
			1 project	490
Eastern	O-28 Makungwa	5		
	O-30 Vuu	13		
	O-31 Lusowe	10		
	3 projects	28		
Total	9 projects	267	21 project	16,484

(2) Multipurpose Dam Development Project

Three multipurpose dams are proposed, namely Chongwe, Kafubu and Mutundu whose outlines are shown in Table 4-7. The purpose of the Chongwe Dam development is to provide water to Lusaka urban area and to irrigation in surrounding area. The volume of water developed with Chongwe Dam project is estimated as 172 thousand m^3/day. The

Kafubu Dam is planned to provide water for municipal water supply to Ndola and Luanshya and irrigation projects along the river with the volume of 430 thousand m^3/day of water developed. Mutundu Dam is planned with the volume of 170 thousand m^3/day of water developed for water supply to Kitwe, Kalulushi, Mufulira, and irrigation around Kitwe. These three dams are selected as peri-urban irrigation projects which are able to produce valuable crops like vegetables. Irrigation water is pumped up to the beneficial area by pumps in all projects. Total irrigation area of multipurpose dam projects amounts to 6,590 ha.

Table 4-7 Outline of Multipurpose Dams Plan

Items	Chongwe Dam	Kafubu Dam	Mutundu Dam
(1) Dam Site	- 45 km east of Lusaka, - 1 km in the east of Chongwe	- 30km south-west of Ndola, - 15km Southeast of Luanshya	- 15km north of Kitwe, - 15km south of Mufulira
(2) Dam Type	Fill Type	Fill Type	Fill Type
(3) Dam Height	37.0 m	27.0 m	30.0 m
(4) Dam Volume	1,315,000 m^3	795,000 m^3	981,000 m^3
(5) Maximum Volume of Water Developed	173,000 m^3/day (2.002 m^3/sec)	430,000 m^3/day (4.977 m^3/sec)	170,000 m^3/day (1.968 m^3/sec)
(6) Purpose (volume of water to be developed as in Base Scenario - Agricultural Expansion)	- Water Supply:103,000m^3/day (Lusaka, Chongwe) - Irrigation: 70,000 m^3/day (810ha in the suburbs of Chongwe by Pump)	- Water Supply: 65,000m^3/day (Ndola, Luanshya) - Irrigation: 365,000m^3/day (4,220ha along the Kafubu River by Pump)	- Water Supply: 35,000m^3/day (Kitwe, Kalulushi, Mufulira) - Irrigation: 135,000m^3/day (1,560ha in the suburbs of Kitwe by Pump)

(3) Irrigation Dam Development Project

Among remaining dams, two dams namely Lufubu and Lundazi dam are selected from viewpoints of economical aspect and gravity conveyance system. Total irrigated area of irrigation dam projects amounts to 8,480. Outline of irrigation dams are as follows:

Table 4-8 Outline of Irrigation Dams Plan

Items	Lufubu Dam	Lundazi Dam
(1) Dam Site	50 km in the north-north-east of Mansa, 60 km in the south-east of Mwense (Luapula Province)	30 km in the north-west of Lundazi, 100 km in the south-south-east of Chipata (Eastern Province)
(2) Dam Type	Fill type	Fill type
(3) Dam Height	33.0 m	38.0 m
(4) Dam Volume	618,000 m^3	552,000 m^3
(5) Maximum Volume of Water Developed	1,211,000 m^3/day (14.02 m^3/s)	160,000 m^3/day (1.86 m^3/s)
(6) Irrigation Plan - Area Developed - Irrigation Method - Irrigation water	7,000 ha Gravitational Irrigation 7.00 m^3/s	1,480 ha Gravitational Irrigation 1.48 m^3/s

An economic analysis has been given for selection of irrigation dams. Equivalent cost and EIRR of three dams have been used for the analysis. Equivalent cost is the unit cost which is calculated dividing total construction cost of irrigation project including dam and

irrigation facilities by the beneficial area. It is generally justified as economic in case that the unit equivalent cost is below US$ 15,000/ha. Unit equivalent costs of selected 17 dams are plotted in Figure 4-2. As shown in the figure, unit equivalent cost of Lufubu dam is the lowest below US$ 10,000/ha. Unit equivalent cost of Lundazi dam is below US$ 20,000/ha. On the other hand, economic rate of return (EIRR) of two irrigation dam projects are estimated at 21.3% and 18.1% respectively. Those two irrigation dam projects are justified as economic (EIRR>10%). Other than two selected irrigation dams, unit equivalent cost of Lunsemfwa dam is the cheapest of about US$24,000/ha. The Lunsemfwa dam needs pumps and pipelines for irrigation. Three dams are regressed as shown in Figure 4-1 using following data.

Evaluation data of Irrigation Dam Project

Name of Dam	(unit)	Lufubu Dam (D-1)	Lundazi Dam (D-18)	Lunsemfwa Dam (D-11)
Beneficial Area	(ha)	7,000	1,480	4,300
Gravity Area	(ha)	7,000	1,480	0
Capital Cost	M'US$	56.96	26.13	103.92
Replacement Cost	M'US$	0	0	21.93
O/M Cost	M'US$/yr	1.036	0.475	2.835
Benefit	M'US$/yr	24.85	9.487	15.27
Proposed Crops and Unit Benefit		Veg.-Veg. : 20% Wheat : 40% Fruit : 40% US$3,550/ha	Veg.-Veg. : 100% USUS6,410	Veg.-Veg. : 20% Wheat : 40% Fruit : 40% US$3,550/ha
Equivalent Unit Cost	US$/ha	8,000	18,000	24,000
EIRR	%	21.3%	18.1%	6.9%

As shown in Figure 4-1, Lunsemfwa dam is evaluated as low from economic aspect. From this matter, remote dams with pump irrigation are necessary to reduce their equivalent unit cost lower than US$15,000, because high value crops like vegetables are not able to be introduced due to distance to market. In case of the exclusive irrigation dam, it will not be fully able to introduce high value crops fully. Lundazi dam is, however, proposed to introduce double cropping of vegetables, due to no other possible large vegetable production sites in Eastern Province. Even vegetables are not fully introduced, Lundazi dam will be expected to keep EIRR higher than 10% from liner relation in Figure 4.1.

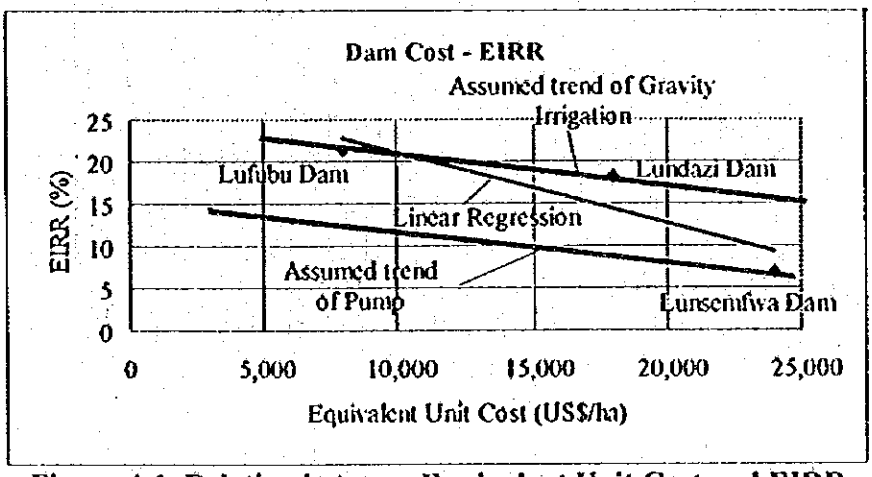


Figure 4-1 Relation between Equivalent Unit Cost and EIRR

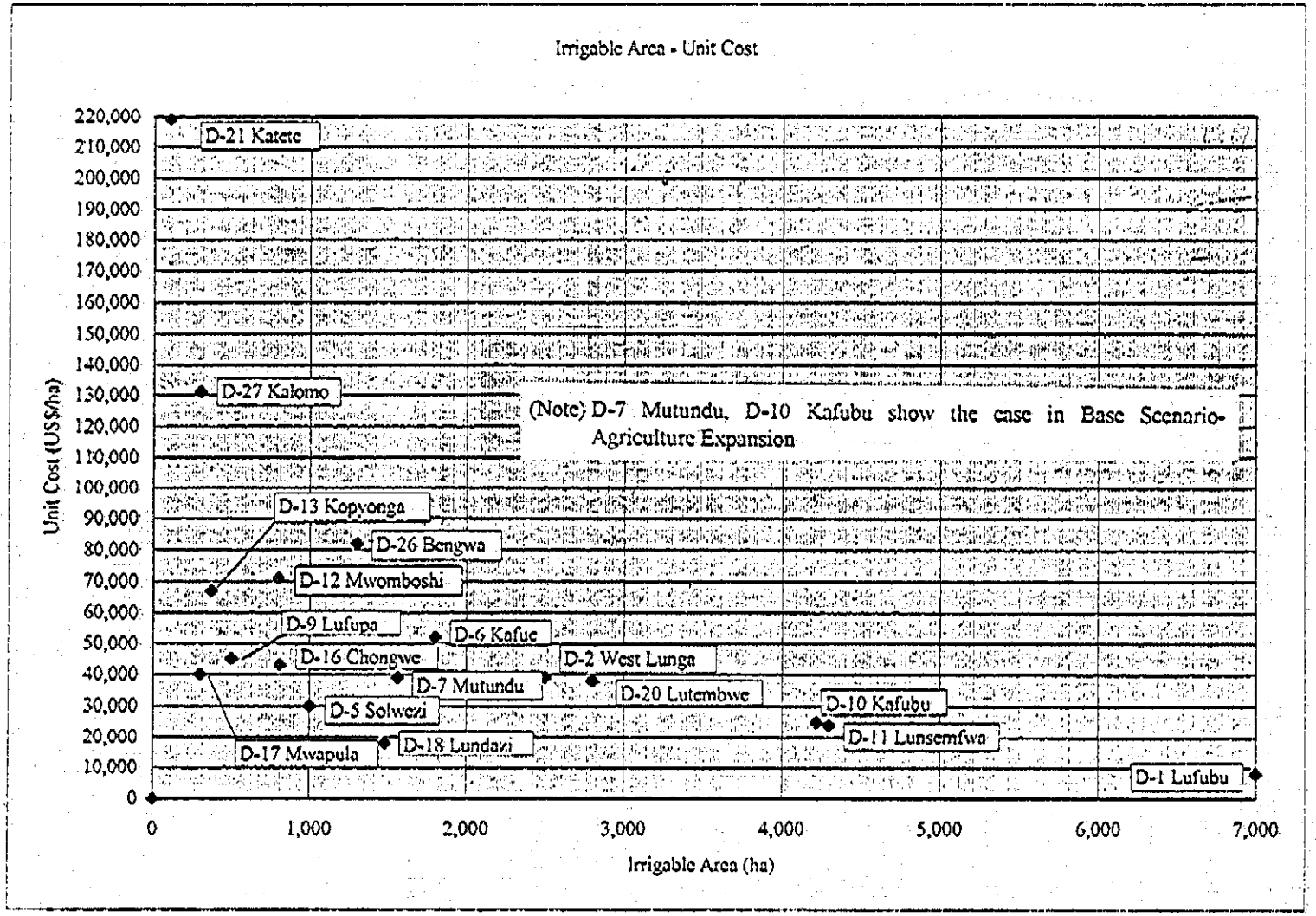


Figure 4-2 Dam Cost Evaluation Chart

(4) Selection of Run-of-River Development Project

Run-of-river development projects are selected to meet necessary provincial allocation of irrigation area based on following considerations:

- In case provincial allocation of development area is satisfied with the ASIP Rehabilitation Projects, the Existing Expansion Projects or the dam development project, no more projects are proposed in such province. (Lusaka, Copperbelt and Southern Provinces are satisfied as shown in Table 4-5)
- Irrigation areas are to be irrigated by gravity as much as possible.
- Larger run-of-river projects will be selected than smaller one taking scale merit into consideration especially for pump irrigation.
- Project sites are to be as much as close to provincial centre city.
- Easier to access to electricity and main road networks.

under above considerations, selected Run-of-River Development Projects are 13 projects, and 29,000 ha in acreage as summarised as below:

Table 4-9 Outline of Run-of-River Development Project (ha)

Central	N/western	Western	Luapula	Northern
P-1 Machiya 5,000	P-79 Mwombeshi 1,000	P-16 Katima Mullilo 1,000	P-37 Mushota Island 2,000	P-52 Chinakila 1,700
	P-80 Mwinilunga 2,300	P-23 Zambezi Floodplain 3,000	P-45 Luapula 2,000	P-65 Chilbula South 5,000
	P-82 Kabompo 3,000	P-84 Ngambwe Rapid 1,000		
		P-86 Manto Rapid 1,000		
		P-88 Sioma Rapid 1,000		
1 project 5,000	3 projects 6,300	5 projects 7,000	2 projects 4,000	2 project 6,700
13 projects 29,000 ha				

4.1.5 Definition of Selected Project by Scenarios

Proposed acreage of irrigation development differs by scenario. It is necessary to define the projects by scenario. Maximum acreage is 61,000 ha in Base Scenario- Agricultural Expansion, and followed by Base Scenario- Industrialisation of about 54,000 ha. Minimum acreage is 38,000 ha in case of Conservative Scenario. Adjusted acreage and project are shown in Table 4-10. Lufubu dam will be excluded in Conservative Scenario, and some of Run-of-River Projects are excluded in both cases for Base Scenario-Industrialisation and Conservative Scenario. Table 4-10 shows the proposed irrigation plan for each scenario.

Table 4-10 Irrigation Development Plan of Each Scenario

Project	Base Scenario-Agricultural Expansion		Base Scenario-Industrialisation		Conservative Scenario	
	Irrigation Area (ha)		Irrigation Area (ha)		Irrigation Area (ha)	
	(2005)	(2015)	(2005)	(2015)	(2005)	(2015)
Lusaka Prov.	**2,720**	**2,720**	**2,720**	**2,720**	**2,720**	**2,720**
Chongwe Dam	810	810	810	810	810	810
ASIP Rehabilitation	10	10	10	10	10	10
Expansion Project	1,900	1,900	1,900	1,900	1,900	1,900
Copperbelt Prov.	**4,340**	**10,120**	**4,340**	**8,850**	**4,340**	**10,700**
Kafubu Dam	–	4,220	–	3,470	–	4460
Mutundu Dam	–	1,560	–	1,040	–	1900
ASIP Rehabilitation	140	140	140	140	140	140
Expansion Project	4,200	4,200	4,200	4,200	4,200	4,200
Central Prov.	**5,000**	**5,000**	**5,000**	**5,000**	**0**	**0**
New Project : P-1	5,000	5,000	5,000	5,000	0	0
Northwest Prov.	**2,590**	**6,590**	**2,590**	**3,590**	**290**	**2,590**
Expansion Project	290	290	290	290	290	290
New Project : P-79	–	1,000	–	1,000	0	0
New Project : P-80	2,300	2,300	2,300	2,300	0	2,300
New Project : P-82	–	3,000	–	0	0	0
Western Prov.	**2,510**	**7,010**	**2,510**	**6,010**	**10**	**3,510**
Expansion Project	10	10	10	10	10	10
New Project : P-16	1,000	1,000	1,000	1,000	0	1,000
New Project : P-23	1,500	3,000	1,500	3,000	0	2,500
New Project : P-84	–	1,000	–	1,000	0	0
New Project : P-86	–	1,000	–	0	0	0
New Project : P-88	–	1,000	–	1,000	0	0
Southern Prov.	**8,539**	**8,539**	**8,539**	**8,539**	**8,539**	**8,539**
ASIP Rehabilitation	89	89	89	89	89	89
Expansion Project	8,450	8,450	8,450	8,450	8,450	8,450
Luapula Prov.	**3,144**	**12,144**	**3,144**	**12,144**	**0**	**3,144**
Lufubu Dam		7,000		7,000	0	0
Expansion Project	1,144	1,144	1,144	1,144	0	1,144
New Project : P-37	2,000	2,000	2,000	2,000	0	2,000
New Project : P-45		2,000		2,000	0	0
Northern Prov.	**2,190**	**7,190**	**490**	**5,490**	**490**	**5,490**
Expansion Project	490	490	490	490	490	490
New Project : P-52	1,700	1,700	0	0	0	0
New Project : P-65	–	5,000	–	5,000	0	5,000
Eastern Prov.	**28**	**1,508**	**28**	**1,508**	**28**	**1,508**
Lundazi Dam	–	1,480	–	1,480	–	1,480
ASIP Rehabilitation	28	28	28	28	28	28
Total	**32,061**	**60,821**	**29,361**	**53,851**	**16,417**	**38,201**