Table G.2 EXISTING /PROPOSED/ABANDONED AGRICULTURAL PROJECTS/FARMS IN THE RUVU RIVER BASIN

Serial No.	Project Title	Ownership	Present Status	Potential Project/Farm Area (ha)	Developed/ Cultivated Area (ha)	Irrigation Area (ha)			Water Right (lit./sec.)	Remarks
						Proposed	Designed	Existing		
Lower Ruvu River Basin										
1	NAFCO	Public	Existing	3,200	3,200	725	725	145	21.83	Data of irrigation area in 1989
2	J.K.T Ruvu (Ruvu National Service Rice Irrigation Project)	Public	Existing	2,370	24	200	200	24	894.22 -	
3	Ruvu Secondary School	Public	Existing	12	5	-	-	-	-	Farm for Training to Students
4	Mr. Mabruk Farm	Private	Proposed	390	-	-	-	-	-	
5	P.A.C Masuguru Farm	P.A.C	Existing	400	30	-	-	-	-	
6	Mzizima Farm	Private	Existing	1,640	30	200	-	-	-	
7	Mr. Mtawale	Private	Proposed	50	-	-	-	-	-	
8	Kigongoni Prison Farm	Public	Existing	650	650	450	20	20	-	
9	Bagamoyo Irrigation Development Project	Public	Existing	2,500	8	1,000 -	100 -	8 -	84.96 -	Phase 1 : Experimental Farm of 8 hectares
10	Makurunge Farm	Public	Abandoned	150	-	-	-	-	-	
11	Matushita Farm	Private	Abandoned	400	-	-	-	-	-	
12	Geneta Farm	Private	Proposed	4,000	-	-	-	-	-	
13	SIAFCO	Private	Proposed	200	-	-	-	-	-	
14	FARUHI	Private	Abandoned	230	-	-	-	-	-	
15	SAZI Farm	Private	Proposed	500	-	20	-	-	-	
16	Kitonga Village Irrigation	Village	Proposed	2,400	2,400	2,400	-	-	-	Small scale low lift pumping irri.
17	Mama Mhando	Private	Existing	150	100	-	-	-	-	
Upper Ruvu Basin										
18	Mlali Irrigation Project	Public	Existing	400	60	400	0	-	-	Siltation problem is severe.
19	Mgeta Rural	Public	Existing	2,000	2,000	2,000	2000	-	-	
20	Mgeta Plain	Public	Existing	-	-	-	-	-	-	

Table G.3 REGISTERED WATER RIGHTS IN THE RUVU RIVER BASIN

Reg. No.	Grantee	Region	Water Sources	Amount (m3/sec)	Purpose	Remarks
Irrigation / Livestock						
609	Chhtlar Shivramvyas & VKB	Bagayomo	Ruvu River	0.0033	Dom./Irr.	
798	Chow Hsien	Bagayomo	Ruvu River	0.0033	Dom./Irr.	
966	JWT Holloway	Bagamoyo	Ruvu River	0.1710	Dom./Liv./Irr/Ind.	
1012	H.kumbruch	Bagayomo	Ruvu River	0.1133		
1023	Ruvu Valley Sugar Co.,Ltd.	Bagamoyo	Ruvu River	0.4319	Dom./Irr/Ind.	
1024	Ruvu Valley Sugar Co.,Ltd.	Bagayomo	Msumbiji River	0.2903	Irr./Dom./Liv.	
1025	George Stylianos	Morogoro	Ngerengere River	0.0005	Irr./Liv.	
1036	Director National Service	Bagayomo	Ruvu River	0.8496		
1417	P.S. Ministry of Agriculture	Morogoro	Kikundi River	0.0071	Dom./Irr.	
1418	P.S. Ministry of Agriculture	Morogoro	Kikundi River	0.0142	Dom./Irr.	
1419	P.S.Agriculture	Morogoro	Mlali River	0.0071	Dom./Irr.	
1487	NACO Ltd.	Morogoro	Ngerengere River	0.0068	Dom./Liv.	
2877	Bagamoyo District Council	Bagamoyo	Ruvu River	0.0037	Dom./Liv.	
2897	Director Production Kilimo	Bagamoyo	Ruvu River	0.0184		
2900	Director Production Kilimo	Bagamoyo	Msua River	0.0034	Dom./Liv.	
3297	Morogoro Native Authority Council	Morogoro	Nyambuywa River	0.0142	Dom./Irr.	
3299	Morogoro Native Authority Council	Morogoro	Mzinga River	0.0142	Dom./Irr.	
3301	Morogoro Native Authority Council	Morogoro	Mgera River	0.2832	All Purpose	
3302	Morogoro Native Authority Council	Morogoro	Ngadangi River	0.0028	Dom./Irr.	
3333	Edward Seitz	Morogoro	Mgeta River	0.1427	Dom./Irr.	
3335	Fatehai K. Ramji	Morogoro	Karoka River	0.0016	Dom./Irr.	
3338	Tom Henshaw	Morogoro	un-named stream	0.0001	Dom./Irr.	
3502	Provincial Agriculture Officer	Morogoro	Morogoro River	0.0142		
3503	Provincial Agriculture Officer	Morogoro	Morogoro River	0.2131		
3507	Commissoner of Prisons	Morogoro	Ngerengere River	0.0040	Dom./Liv.	
3513	Commissoner of Prisons	Morogoro	Ngerengere River	0.0034	Dom./Ind./Liv.	
3528	Morogoro Town Council	Morogoro	Kirakala River	0.0001	Irrigation	
3550	Fazal Kassani Mills Ltd.	Morogoro	Ngerengere River	0.0355	Dom./Irr.	
3562	The Procura, the Holy Fathers	Morogoro	Mgeta River	0.0053	Dom./Irr.	
3564	The Procura, the Holy Fathers	Morogoro	Bigwa River	0.0033	Dom./irr.	
3571	The Procura, the Holy Fathers	Morogoro	Spring Near Mgeta River	0.0014	Dom./Irr.	
3581	Morogoro District Council	Morogoro	Mlali River	0.1416	Irrigation	
3623	Morogoro Native Authority Council	Morogoro	Mzinga/Mindu River	0.0284	Dom./Irr.	
3962	Edward Seitz	Morogoro	Mgeta River	0.1427	Dom./Irr.	
4449	DDD. Bagamoyo	Bagayomo	Ruvu River	0.0850		
4553	Deocese of Morogoro	Morogoro	Mgololo River	0.0013	Ind./Irr.	
4570	The Procura, the Holy Fathers	Morogoro	Tangeni River	0.0006		4570 + another right
4602	Taj Mohamed	Morogoro	Mgera River	0.0079	Dom./Ind./Liv.	
4700	Director Sugarcane Breeding Sta. Kibaha	Kibaha	Ruvu River	0.5675	Dom./Irr/Ind.	
4805	United Farming Co.,Ltd.	Kibaha	Ruvu River	0.8942	Dom./Irr.	
4828	Bigwa Folk Dev. Colledge	Morogoro	Mgolole River	0.0050	Dom./Irr./Liv.	
4855	G.Sambetakis	Morogoro	Well near Ngere. River	0.0001	Dom./Irr.	
4859	A.N.C. Mazibabu	Morogoro	Ngemgere River	0.0167	Irrigation	Expired Mar.'92
4868	Wilson M.Karuwesa	Morogoro	Lukuyu River	0.0123	Dom./Irr./Liv.	Expired Mar.'92
4883	Registar SUA	Morogoro	Ngemgere River	0.0007	Irrigation	
	TOTAL			4.5667		

Ministy of Water, Energy and Minerals

Table G.4 DATA ON LIVESTOCK IN BAGAMOYO DISTRICT

(1) LIVESTOCK RAISING — Unit: Head

Animals	1984	1985	1986	1987	1988	1989	1990
Cattle	55714	57385	59107	60880	62706	64587	66525
Gaots	10028	10329	10639	10958	11287	11626	11975
Sheep	2844	2929	3017	3118	3201	3297	3396
Chicken	87555	90182	92887	95674	98544	101500	104545
Geese	5118	5267	5425	5588	5756	5930	6108
Guene	193	199	205	211	217	224	231
Turkey	15	16	17	18	19	20	21
Pig	769	792	816	840	865	874	900
Rabit	63	65	67	69	71	73	75
Donkey	27	28	29	30	31	32	33

Source: D.A.D.O. Bagamoyo, 1992

(2) LIVESTOCK PRODUCTION

Products	Unit	1984	1985	1986	1987	1988
Beef	kg	19990	314818	193156	192801	175640
Goat meat	kg	274	480	1914	509	614
Mutton	kg	15	-	-	-	-
Pork	kg	105	2314	4498	1580	-
Eggs	No.	204299	33431	151207	226001	192842
Butter	kg	1050	-	9550	3350	4750
Milk	kg	107857	409676	207951	271967	268242
Chicken	kg	11457	11609	11341	4719	6769
Cattle skin*		1980	913	1773	2601	2876
Goats slin	n *	-	480	12	48	46
Sheep skin	n *	15	-	-	-	-

Note: * Piece.

Source: Agriculture and Livestock Dev.D.C.O. Bagamoyo 1992.

(3) CONSUMPTION OF ANIMAL PRODUCTS PER CAPITA PER YEAR

Products	Unit	1984	1985	1986	1987	1988
Beef	kg	0.2	1.8	1.12	1.12	1.02
Goat	kg	0.003	0.003	0.01	0.003	0.004
Chicken	kg	0.067	0.068	0.07	0.03	0.04
Pork	kg	-	0.013	0.03	0.01	0.001
Eggs	kg	2	0.19	1.5	1.3	1.12
Milk	kg	1.2	1.5	1.21	1.6	1.7
Butter	kg	0.007	0.009	0.01	0.02	0.03

Source: Agliculture and Livestock Dev. D.C.O. Bagmoyo 1992.

Table G.5 DATA ON LIVESTOCK IN BAGAMOYO AND KIBAHA DISTRICTS

(1) LIVESTOCK GRAZING

District/Village	Cattle	Goats	Sheep	Chicken
Bagamoyo				
Ruvu Darajani	1486	289	275	1414
Vigwaza	934	10	-	1396
Visezi	2342	117	12	1451
Kibaha				
Mlandizi	38	1	-	2768
Vikuruti	32	-	-	1134
Mbwawa	-	32	-	2627
Miswe	-	19	-	2058
Kwala	2962	176	47	1250
Mwanabwito	215	31	7	344
Ruvu Mjuu	-	15	-	765
1984 Livestock Census.	8009	690	341	15207
As of 1993.	9996	841	426	18991

Source: Regional Commissioner's Office, Caost Region 1992

Table G.6 DATA ON LIVESTOCK IN MOROGORO DISTRICT

(1) LIVESTOCK GRAZING

Ward	Cattle	Goats	Sheep	Pig	Rabbits
Kisaki		1112	195	180	58
Mangazi		26		18	120
Singisa		193	2	100	
Mzinga		3614	144		
Kingolwira	2604	854	247	320	282
Mikese	262	355	37	206	100
Tegetero	6	1750	1028		5
Kinole		371	35		18
Kiroka		518	48		15
Mkuyuni		921	63		
Mzunbe		424	30		
Melela	4368	1375	380	10	90
Mlali	788	8		190	56
Doma		442	23		
Kidugalo	2111	316	77	100	9
Tununguo	1280	137	105	106	6
Ngerengere		90	5	90	
Kibogwa		4689	153	70	
Kubungo		801	144		
Kisemu		1351	197	25	
Lundi		1313	34	35	
Mtonbozi		1929	140		
Tawa		1707	5		
Bunduki		1312	1406	1060	764
Kikeo		1657	117	905	908
Langali		2061	314	2446	1092
Tchenzewa		1272	271	2068	
Kasanga		1764	159		35
Kolero		1770	171		10
Mvuha		681	506		7
Total	11419	34813	6036	7929	3575

Source: D.A.D.O.Morogoro Rural 1984.

Table G.7 WOOD CONSUMPTION IN THE RUVU RIVER BASIN

Year	Charcorl (bags)	Firewood (M3)	Logs (M3)	Withies (M3)	Poles (Unit)
Bagamoyo District					
85/86	326458	2121	1043	364	106
86/87	471423	1311	1385	242	254
87/88	311257	2223	341	172	150
88/89	244276	4107	14458		735
89/90	101391	1338	599	267	346
90/91	207789	1900	953		537
91/92	161605	2868	287	135	792
Average	260600	2267	2724	236	417
Kibaha District					
85/86	16412	1873	19	1741	2752
86/87	60310	1622	39	1444	1615
87/88	62484	2175	48	420	2875
88/89	46874	2298	53	618	1454
89/90	16265	1887		570	2006
90/91	10037	983	38	235	1064
91/92	7563	167	28	246	1744
Average	31421	1572	37	753	1930
Kisarawe District					
85/86	279623	19403	506	6364	92301
86/87	205082	16705	340	2144	29581
87/88	282309	13158	811	5160	27327
88/89	201000	8500	405	27200	21350
89/90	242000	9500	230	35000	24000
90/91	251000	8000	165	30000	28000
91/92	181772	16433	435	21190	41280
Average	234684	13100	413	18151	37691
Morogoro Rural District					
85/86	46287	12564	1853	unknown	941
86/87	52106	5685	2297		2075
87/88	20654	2695	2005		1244
88/89	34165	1549	1595		953
89/90	71361	1463	1769		1051
90/91	31435	2510	1155		490
91/92	19227	1404	1585		500
Average	39319	3981	1751		1036

Source: District Forest Office.

Table G.8 SUMMARY TABLE OF AGRICULTURAL PROJECT

Project Title	Location	Project Type	Potential Area (ha)	Project Area (ha)	Project Description
Bagamoyo Irrigation Development Project	Lower Ruvu	Extension	1,100	1,100	The project area comprises Bagamoyo Irrigation Development Project (BIDP) area of 1,000 ha and a private farm area of 100 ha BIDP is under phased development as follows; - Phase 1 Experimental Farm of 8ha (existing) - Phase 2 Pilot Farm of 100ha (under construction) - Phase 3 Full development of 1,000 ha by gravity irrigation (proposed) As the irrigation water resources, construction of large scale reservoir(s) is required for dry season.
Low-lift Pump Irrigation Project	Lower Ruvu	New Development	2,400	50 Pilot Farm	The project is requested by farmers. Irrigation will be done by small scale and removable type pumps utilizing existing ponds as a water resource. Equipment will be managed by farmers' group. As a trial, pilot farm of 50 ha will be a proper size of the project.
Makurunge Irrigation Project	Lower Ruvu	Rehabilitation	150	150	Reconstruction of the abandoned pump irrigation scheme. At present the area is cultivated by farmers from Makurunge village under rainfed condition.
Ruvu National Youth Irrigation Project	Lower Ruvu	Rehabilitation	800	200	Rehabilitation of the existing pump irrigation scheme of 24 ha and construction of remaining area of 176 ha The project is operated by National Youth Service.
Kidunda Irrigation Project	Middle Ruvu	New Development	26,500	15,600	Proposed project area is located in the floodplain of the Ruvu river. At present almost no agricultural activities in the area. Construction of Kidunda dam is necessary for this project.
Ngerengere Irrigation Project	Middle Ruvu	New Development	3,500	3,500	Proposed project area is located in the floodplain of the Ruvu river. At present no agricultural activities in the area. Construction of Ngerengere dam is necessary for this project.
Uluguru Mountains East Project	Upper Ruvu Uluguru Mountains	Rehabilitation and Development	16,000	16,000	Project component - Watershed management - Rehabilitation of trunk rural road (Morogoro-Kisaki) - Construction of agricultural marketing facilities especially for fruits
Mgeta Plain Irrigation Project	Mgeta Plain	New Development	25,000	7,000	Both banks of the Mgeta River are the potential area. However, existence of Selous Game Reserve limits the development of the right bank. Construction of Mgeta dam is necessary for this Project.
Mgeta Plain Mvuha Irrigation Project	Mgeta Plain	New Development	5,000	5,000	The potential area is estimated on the basis of the information from farmers. Basic data for development are not available. Farmers have a strong intention of irrigating for their field under rainfed condition.
Mlali Irrigation Project	Vicinity of Morogoro Uluguru Mountains	Rehabilitation	800	400	This project has a high priority in the FAO's study and in the Regional office. The project has suffered from serious sedimentation at the weir site. Irrigation facilities are also deteriorated . In addition to the existing area of 150 ha, an area of 250 ha is proposed to be extended.
Uluguru Mountains West Project	Uluguru Mountains West side slope	Rehabilitation and Development	2,000	2,000	Project component - Watershed management: Afforestation - Rehabilitation and improvement of existing traditional irrigation system for erosion control - Improvement of trunk rural road (approx. 42 km) The area is the Vegetable Zone for Dar Es Salaam and Morogoro city.

Table G.9 TRADDITIONAL IRRIGATION SYSTEM IN THE ULUGURU MOUNTAIN WEST

Ward	Village	Name of Canal	Numbers of Users	Length of Canal* (km)
BUNDUKI	Bunduki	Mkungu-Hangula	800	5.00
		Chogu-Hangula	200	3.00
	Kibigiri	Yao-Lunene	700	3.00
		Yao-Mahame	300	2.50
		Mwehengare-Horwe	150	1.00
		Yombo-Minyange	300	1.50
		Yombo-Nyakinde	100	1.00
	Maguruwe	Maguruwe-Luhanga	200	5.00
		Kibangusa-Luzangwa	unknown	
	Tandari	Mwarazi-Msani	600	5.00
	Vinile	MwenyeVinile-Tawa	300	2.00
		MwenyeVinile-Tambazi	200	2.00
		Hangulo-Misalani	200	1.50
KIKEO	Luale	Mluzu	Masarawe primary	3.00
		Kibelunga	School + Farmers	2.50
		Notzi A&B	unknown	1.50
	Lukunguni	Kidege		1.50
		Lukunguni		
		Kiloko	No data available	
		Kiwaga		
		Kiguruvuni		
		Tambalagani		
		Lukenge		
		Nyamilonda A&B		
LANGALI	Langali	Mzinga A&B	100	2.50
		Mindu Juu	200	2.00
		Mindu Chini	200	1.50
	Kibaoni	Kibaoni	200	4.50
		Nyandu	250	4.50
	Pinde	Mula	Pinde Prim. School + Farmers	2.00
		Yombo	unknown	
TCHENZEMA	Ngungulu	Kisanza-Maji	unknown	3.70
		Ngasowa	unknown	3.70
	Kibuko	Kibuko	50	1.00
		Mluzi	200	3.00
		Lubugulu	120	2.00
		Kisangile	60-70	1.50
	Nyandira	Mzinga	Almost all Nyandira villagers	5.00
		Mindu	100	1.00
	Tchenzema	Kologha	20	0.50
		Mtamba	200	3.00
		Kimgonigo	100	4.00
		Silu	150	5.50
		Kinavu	90	4.50
		Kubungu	120	3.00
		Vizona	100	3.50
		Msimambe	50	1.50
		Msunguti	70	2.00
		Zagila	150	5.00
		Mgungolo	200	4.50
		Msonzo	100	4.50
		Tchenzema	Primary School, Church and Farmers union	0.50
		Kidando A	50	0.50
		Kidando B	50	0.50
		Visinde	50	0.60
		Mizona	50	0.50
		Mtuguto	100	1.00
		Ngongolo	20	0.25
		Vikoza	70	0.50
		Mbehoni	100	0.50
		Kipugulu	200	3.00
		Nyamigadu	300	1.60
		Kitamba	80	0.70
		Wala	100	2.00
		Kirumba	100	2.00

Note : * Estimated Length

Table G.10 (1) IRRIGATION WATER REQUIREMENT OF PADDY IN THE LOWER RUVU BASIN

	Cropping Calendar of Paddy											
					Rainy Season Paddy					Dry Season Paddy		
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
A) Potential Evapotranspiration (mm/day)	4.80	6.10	4.40	3.70	3.40	3.40	3.70	3.90	4.40	5.10	5.20	4.60
Potential Evapotranspiration (mm/month)	148.8	170.8	136.4	111.0	105.4	102.0	114.7	120.9	132.0	158.1	156.0	142.6
B) Crop Coefficient	1.00		1.10	1.15	1.35	1.25	1.00		1.10	1.15	1.35	1.25
	1.00	0.00	1.10	1.15	1.35	1.25	1.00	0.00	1.10	1.15	1.35	1.25
Average of Crop Coefficient	1.00	0.00	1.10	1.15	1.35	1.25	1.00	0.00	1.10	1.15	1.35	1.25
C) Corp Water Requirement (mm/month) = A x B(ave.)	148.8	0.0	150.0	127.7	142.3	127.5	114.7	0.0	145.2	181.8	210.6	178.3
D) Percolation	62.0	56.0	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
E) Puddling Water Requirement (mm)			50.0							50.0		
F) = C)+D)+E)	210.8	56.0	262.0	187.7	204.3	187.5	176.7	62.0	205.2	293.8	270.6	240.3
Monthly Rainfall (mm) *	70.0	55.0	83.0	189.0	171.0	39.0	29.0	59.0	24.0	59.0	83.0	117.0
F) Effective Rainfall (= Monthly Rainfall * 50%)	35.0	27.5	41.5	94.5	85.5	19.5	14.5	29.5	12.0	29.5	41.5	58.5
G) Net Irrigation Requirement (G = C+D+E-F)	175.8	0.0	220.5	93.1	118.8	168.0	162.2	0.0	193.2	264.3	229.1	181.8
H) Irrigation Efficiency (= 50%)												
I) Irrigation Water Requirement (I = G/H) in mm/mont	351.6	0	441.1	186.3	237.6	336	324.4	0	386.4	528.6	458.2	363.5
Monthly Irrigation Water Requirement (m3/ha/month	3,516	0	4,411	1,863	2,376	3,360	3,244	0	3,864	5,286	4,582	3,635
Unit Irrigation Water Requirement (lit./sec./ha)	1.31	0.00	1.65	0.70	0.89	1.25	1.21	0.00	1.44	1.97	1.71	1.36

* Rainfall Data at Bagamoyo Salt Farm

Table G.10 (2) IRRIGATION WATER REQUIREMENT OF MAIZE IN THE LOWER RUVU BASIN

	Cropping Calendar of Maize											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
A) Potential Evapotranspiration (mm/day)	4.80	6.10	4.40	3.70	3.40	3.40	3.70	3.90	4.40	5.10	5.20	4.60
Potential Evapotranspiration (mm/month)	148.8	170.8	136.4	111.0	105.4	102.0	114.7	120.9	132.0	158.1	156.0	142.6
B) Crop Coefficient			0.30	0.70	0.90	0.65			0.30	0.70	0.90	0.65
	0.65			0.30	0.70	0.90	0.65			0.30	0.70	0.90
Average of Crop Coefficient	0.65	0.00	0.30	0.50	0.80	0.78	0.65	0.00	0.30	0.50	0.80	0.78
C) Corp Water Requirement (mm/month) = A x B(ave.)	96.7	0.0	40.9	55.5	84.3	79.1	74.6	0.0	39.6	79.1	124.8	110.5
D) Percolation	62.0	56.0	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
E) Puddling Water Requirement (mm)			50.0						50.0			
F) = C)+D)+E)	158.7	56	152.9	115.5	146.3	139.1	136.6	62	149.6	141.1	184.8	172.5
Monthly Rainfall (mm) *	70.0	55.0	83.0	189.0	171.0	39.0	29.0	59.0	24.0	59.0	83.0	117.0
F) Effective Rainfall (= Monthly Rainfall * 50%)	35.0	27.5	41.5	94.5	85.5	19.5	14.5	29.5	12.0	29.5	41.5	58.5
G) Net Irrigation Requirement (G = C+D+E-F)	123.7	0.0	111.4	21.0	60.8	119.6	122.1	0.0	137.6	111.6	143.3	114.0
H) Irrigation Efficiency (= 45%)												
I) Irrigation Water Requirement (I = G/H) in mm/mont	274.9	0	247.6	46.67	135.2	265.7	271.2	0	305.8	247.9	318.4	253.4
Monthly Irrigation Water Requirement (m3/ha/month	2,749	0	2,476	467	1,352	2,657	2,712	0	3,058	2,479	3,184	2,534
Unit Irrigation Water Requirement (lit./sec./ha)	1.03	0.00	0.92	0.17	0.50	0.99	1.01	0.00	1.14	0.93	1.19	0.95

* : Rainfall Data at Bagamoyo Salt Farm

Table G.10 (3) IRRIGATION WATER REQUIREMENT OF PADDY IN THE MIDDLE RUVU BASIN

	Cropping Calendar											
					Rainy Season Paddy				Dry Season Paddy			
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
A) Potential Evapotranspiration (mm/day)	5.49	5.11	5.57	4.21	3.76	4.83	3.83	4.27	4.59	5.28	6.42	6.86
Potential Evapotranspiration (mm/month)	170.2	143.1	172.7	126.3	116.6	144.9	118.7	132.4	137.7	163.7	192.6	212.7
B) Crop Coefficient	1.00		1.10	1.15	1.35	1.25	1.00		1.10	1.15	1.35	1.25
Average of Crop Coefficient	0.50	0.00	1.10	0.58	0.68	0.63	0.50	0.00	1.10	0.58	0.68	0.63
C) Corp Water Requirement (mm/month) = A x B(ave.)	85.1	0.0	189.9	72.6	78.7	90.6	59.4	0.0	151.5	94.1	130.0	132.9
D) Percolation	62.0	56.0	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
E) Puddling Water Requirement (mm)			50.0						50.0			
F) = C)+D)+E)	147.1	56.0	301.9	132.6	140.7	150.6	121.4	62.0	261.5	156.1	190.0	194.9
Monthly Rainfall (mm) *	116.0	102.0	155.0	217.0	61.0	25.0	8.0	19.0	23.0	81.0	92.0	113.0
F) Effective Rainfall (= Monthly Rainfall * 50%)	58.0	51.0	77.5	108.5	30.5	12.5	4.0	9.5	11.5	40.5	46.0	56.5
G) Net Irrigation Requirement (G = C+D+E-F)	89.1	0.0	224.4	24.1	110.2	138.1	117.4	0.0	250.0	115.6	144.0	138.4
H) Irrigation Efficiency (= 45%)												
I) Irrigation Water Requirement (I = G/H) in mm/month	198	0	498.7	53.61	244.8	306.8	260.8	0	555.5	256.9	320	307.6
Monthly Irrigation Water Requirement (m3/ha/month)	1,980	0	4,987	536	2,448	3,068	2,608	0	5,555	2,569	3,200	3,076
Unit Irrigation Water Requirement (lit./sec./ha)	0.74	0.00	1.86	0.20	0.91	1.15	0.97	0.00	2.07	0.96	1.19	1.15

* Rainfall Data at Kidunda Village

Table G.10 (4) IRRIGATION WATER REQUIREMENT OF MAIZE IN THE MIDDLE RUVU BASIN

	Cropping Calendar of Maize											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
A) Potential Evapotranspiration (mm/day)	5.49	5.11	5.57	4.21	3.76	4.83	3.83	4.27	4.59	5.28	6.42	6.86
Potential Evapotranspiration (mm/month)	170.2	143.1	172.7	126.3	116.6	144.9	118.7	132.4	137.7	163.7	192.6	212.7
B) Crop Coefficient			0.30	0.70	0.90	0.65			0.30	0.70	0.90	0.65
	0.65			0.30	0.70	0.90	0.65			0.30	0.70	0.90
Average of Crop Coefficient	0.65	0.00	0.30	0.50	0.80	0.78	0.65	0.00	0.30	0.50	0.80	0.78
C) Corp Water Requirement (mm/month) = A x B(ave.)	110.6	0.0	51.8	63.2	93.2	112.3	77.2	0.0	41.3	81.8	154.1	164.8
D) Percolation	62.0	56.0	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
E) Other Water Requirement (mm)												
F) = C)+D)+E)	172.6	56	113.8	123.2	155.2	172.3	139.2	62	101.3	143.8	214.1	226.8
Monthly Rainfall (mm) *	116.0	102.0	155.0	217.0	61.0	25.0	8.0	19.0	23.0	81.0	92.0	113.0
F) Effective Rainfall (= Monthly Rainfall x 50%)	58.0	51.0	77.5	108.5	30.5	12.5	4.0	9.5	11.5	40.5	46.0	56.5
G) Net Irrigation Requirement (G = C+D+E-F)	114.6	0.0	36.3	14.7	124.7	159.8	135.2	0.0	89.8	103.3	168.1	170.3
H) Irrigation Efficiency (= 45%)												
I) Irrigation Water Requirement (I = G/H) in mm/month	254.7	0	80.67	32.56	277.2	355.1	300.4	0	199.6	229.6	373.5	378.5
Monthly Irrigation Water Requirement (m3/ha/month)	2,547	0	807	326	2,772	3,551	3,004	0	1,996	2,296	3,735	3,785
Unit Irrigation Water Requirement (lit./sec./ha)	0.95	0.00	0.30	0.12	1.04	1.33	1.12	0.00	0.75	0.86	1.39	1.41

*: Rainfall Data at Kidunda Village

Table G.10 (5) IRRIGATION WATER REQUIREMENT OF COTTON IN THE MGETA PLAIN

	Cropping Calendar of Cotton											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
A) Potential Evapotranspiration (mm/day)	5.57	6.57	5.39	3.88	3.07	3.00	3.31	3.95	5.48	6.25	6.60	6.06
Potential Evapotranspiration (mm/month)	172.7	184.0	167.1	116.4	95.2	90.0	102.6	122.5	164.4	193.8	198.0	187.9
B) Crop Coefficient	0.30	0.65	0.90	0.80	0.45							
		0.30	0.65	0.90	0.80	0.45						
Average of Crop Coefficient	0.30	0.48	0.78	0.85	0.63	0.45						
C) Corp Water Requirement (mm/month) = A x B(ave.)	51.8	87.4	129.5	98.9	59.5	40.5	0.0	0.0	0.0	0.0	0.0	0.0
D) Percolation	62.0	56.0	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
E) Other Water Requirements (mm)												
F) = C)+ D)+ E)	113.8	143.4	191.5	158.9	121.5	100.5	62	62	60	62	60	62
Monthly Rainfall (mm) *	129.0	121.0	206.0	258.0	112.0	28.0	13.0	9.0	20.0	33.0	84.0	100.0
F) Effective Rainfall (= Monthly Rainfall x 50%)	64.5	60.5	103.0	129.0	56.0	14.0	6.5	4.5	10.0	16.5	42.0	50.0
G) Net Irrigation Requirement (G = C+ D+ E-F)	49.3	82.9	88.5	29.9	65.5	86.5	0.0	0.0	0.0	0.0	0.0	0.0
H) Irrigation Efficiency (= 45%)												
I) Irrigation Water Requirement (I = G/H) in mm/month	109.6	184.2	196.7	66.53	145.5	192.2	0	0	0	0	0	0
Monthly Irrigation Water Requirement (m3/ha/month)	1,096	1,842	1,967	665	1,455	1,922	0	0	0	0	0	0
Unit Irrigation Water Requirement (lit /sec./ha)	0.41	0.69	0.73	0.25	0.54	0.72	0.00	0.00	0.00	0.00	0.00	0.00

* : Raiofall Data at Dutumi

Table G.10 (6) IRRIGATION WATER REQUIREMENT OF PADDY IN THE MGETA PLAIN

	Cropping Calendar of Paddy											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
A) Potential Evapotranspiration (mm/day)	5.57	6.57	5.39	3.88	3.07	3.00	3.31	3.95	5.48	6.25	6.60	6.06
Potential Evapotranspiration (mm/month)	172.7	184.0	167.1	116.4	95.2	90.0	102.6	122.5	164.4	193.8	198.0	187.9
B) Crop Coefficient	1.10	1.15	1.35	1.25	1.00							1.00
Average of Crop Coefficient	0.55	0.58	1.35	0.63	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.50
C) Corp Water Requirement (mm/month) = A x B(ave.)	95.0	105.8	225.6	72.8	47.6	0.0	0.0	0.0	0.0	0.0	0.0	93.9
D) Percolation	62.0	56.0	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
E) Puddling Water Requirement (mm)			50.0						50.0			
F) = C)+ D)+ E)	157.0	161.8	337.6	132.8	109.6	60.0	62.0	62.0	110.0	62.0	60.0	155.9
Monthly Rainfall (mm) *	129.0	121.0	206.0	258.0	112.0	28.0	13.0	9.0	20.0	33.0	84.0	100.0
F) Effective Rainfall (= Monthly Rainfall * 50%)	64.5	60.5	103.0	129.0	56.0	14.0	6.5	4.5	10.0	16.5	42.0	50.0
G) Net Irrigation Requirement (G = C+ D+ E-F)	92.5	101.3	234.6	3.8	53.6	0.0	0.0	0.0	0.0	0.0	0.0	105.9
H) Irrigation Efficiency (= 45%)												
I) Irrigation Water Requirement (I = G/H) in mm/month	205.5	225.1	521.3	8.333	119.1	0	0	0	0	0	0	235.4
Monthly Irrigation Water Requirement (m3/ha/month)	2,055	2,251	5,213	83	1,191	0	0	0	0	0	0	2,354
Unit Irrigation Water Requirement (lit./sec./ha)	0.77	0.84	1.95	0.03	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.88

Table G.10 (7) IRRIGATION WATER REQUIREMENT OF MAIZE IN THE MGETA PLAIN

	Cropping Calendar of Maize											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
A) Potential Evapotranspiration (mm/day)	5.57	6.57	5.39	3.88	3.07	3.00	3.31	3.95	5.48	6.25	6.60	6.06
Potential Evapotranspiration (mm/month)	172.7	184.0	167.1	116.4	95.2	90.0	102.6	122.5	164.4	193.8	198.0	187.9
B) Crop Coefficient			0.30	0.70	0.90	0.65			0.30	0.70	0.90	0.65
Average of Crop Coefficient	0.00	0.00	0.30	0.35	0.45	0.33	0.00	0.00	0.30	0.35	0.45	0.33
C) Corp Water Requirement (mm/month) = A x B(ave.)	0.0	0.0	50.1	40.7	42.8	29.3	0.0	0.0	49.3	67.8	89.1	61.1
D) Percolation	62.0	56.0	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0
E) Puddling Water Requirement (mm)												
F) = C)+ D)+ E)	62.0	56	112.1	100.7	104.8	89.25	62	62	109.3	129.8	149.1	123.1
Monthly Rainfall (mm) *	129.0	121.0	206.0	258.0	112.0	28.0	13.0	9.0	20.0	33.0	84.0	100.0
F) Effective Rainfall (= Monthly Rainfall x 50%)	64.5	60.5	103.0	129.0	56.0	14.0	6.5	4.5	10.0	16.5	42.0	50.0
G) Net Irrigation Requirement (G = C+ D+ E-F)	0.0	0.0	9.1	0.0	48.8	75.3	0.0	0.0	99.3	113.3	107.1	73.1
H) Irrigation Efficiency (= 45%)												
I) Irrigation Water Requirement (I = G/H) in mm/month	0	0	20.28	0	108.5	167.2	0	0	220.7	251.8	238	162.3
Monthly Irrigation Water Requirement (m3/ha/month)	0	0	203	0	1,085	1,672	0	0	2,207	2,518	2,380	1,623
Unit Irrigation Water Requirement (lit./sec./ha)	0.00	0.00	0.08	0.00	0.41	0.62	0.00	0.00	0.82	0.94	0.89	0.61

* : Raiofall Data at Dutumi

Table G.11 UNIT DIRECT CONSTRUCTION COST AND MATERIAL COST

(Unit : TSHs)

Item		Unit	Unit Price
Irrigation Works			
Excavation of Large Canal	: Common	m^3	411
Excavation of Small Canal	: Common	m^3	411
Embankment	: Excavated Materia	m^3	589
	: Borrowed Material	m^3	1,116
Backfill		m^3	1,116
Concrete	: Reinforced	m^3	23,588
	: Lining	m^3	16,000
	: Plain	m^3	22,463
Concrete Form		m^2	5,106
Reinforcement Bar		ton	218,000
Wet Stone Masonry		m^3	
Concrete Pipe	: D=600	m	22,229
	: D=800	m	28,200
	: D=1000	m	31,400
Land Leveling		ha	180,000
Road Works			
Rural Roads			
Rehabilitation of gravel road	: Easy	m	14,000
	: Medium	m	16,000
	: Heavy	m	18,000
Upgrading earth road to gravel	: Easy	m	20,000
	: Medium	m	23,000
	: Heavy	m	26,000
Periodic maintenance of gravel road	: Easy	m	16,000
	: Medium	m	18,000
	: Heavy	m	20,000
Bridge (cost per metre)	: Easy	m	14,000
	: Medium	m	18,000
	: Heavy	m	22,000
Trunk Roads		m	
Upgrading surface dress to asphalt concrete	: Easy	m	170,000
	: Medium	m	200,000
	: Heavy	m	240,000
Upgrading gravel to surface dress	: Easy	m	270,000
	: Medium	m	300,000
	: Heavy	m	330,000
Bridge (cost per metre)	: Easy	m	18,000
	: Medium	m	22,000
	: Heavy	m	28,000

Table G.12 SUMMARY OF CONSTRUCTION COST OF IRRIGATION PROJECT

	Bagamoyo Irrigation Development	Low-lift Pump Irrigation	Makurumge Irrigation	Ruvu National Youth Irrigation	Kidunda Irrigation	Ngerengere Irrigation	Uluguru Mountain East	Mlali Irrigation	Mgeta Plain Irrigaiton	Mgeta Plain Mvuha Irrigation	Uluguru Mountain West
1 Construction Cost											
1.1 Preparatory Works	59,350	2,478	8,917	18,141	870,978	128,527	207,823	25,253	393,561	185,757	138,320
1.2 Irrigation & Drainage	297,040	0	11,158	96,574	4,910,300	611,693	0	95,857	2,334,011	848,009	0
1.3 On-farm Development	587,370	30,060	90,180	120,240	9,405,770	1,472,940	633,064	195,390	4,208,400	2,104,200	1,202,400
1.4 Land Development	175,860	9,000	27,000	36,000	2,816,100	441,000	0	45,000	1,260,000	630,000	0
1.5 Other Major Works	126,720	10,500	50,000	110,000	287,385	44,900	3,523,400	168,808	68,800	132,930	1,564,000
1.5.1 Intake Facilities	17,220				287,385	44,900		4,680	68,800	34,450	
1.5.2 Intake Weir	109,500							164,128		98,480	
1.5.3 Access Road Impro.							2,893,400				1,564,000
1.5.4 Fruit Packing, etc.							630,000				
1.5.5 Pump House			50,000	100,000							
1.5.6 Other Works		10,500		10,000							
Sub-Total of Item 1	1,246,340	52,038	187,255	380,954	18,290,532	2,699,060	4,364,287	530,308	8,264,771	3,900,895	2,904,720
1.6 Overhead, Profit	124,634	5,204	18,726	38,095	1,829,053	269,906	436,429	53,031	826,477	390,090	290,472
1.7 Tax											
Total of Item 1	1,370,974	57,242	205,981	419,050	20,119,586	2,968,966	4,800,716	583,338	9,091,248	4,290,985	3,195,192
2 Land Aquisition, Resettlement and Compensation	27,419	1,145	4,120	8,381	402,392	59,379	96,014	11,667	181,825	85,820	63,904
3 O & M Equipment	34,274	0	5,150	10,476	502,990	74,224	120,018	14,583	227,281	107,275	79,880
4 Administration	34,274	1,431	5,150	10,476	502,990	74,224	120,018	14,583	227,281	107,275	79,880
5 Physical Contingency	146,694	5,982	22,040	44,838	2,152,796	317,679	513,677	62,417	972,764	459,135	341,886
Total of Item 1 to 5	1,613,636	65,799	242,439	493,222	23,680,752	3,494,473	5,650,443	686,589	10,700,399	5,050,489	3,760,741
6 Engineering Services	154,577	6,297	23,224	47,248	2,268,483	334,751	541,281	65,771	1,025,038	483,809	360,258
Grand Total (1000 TShs)	1,768,213	72,096	265,664	540,470	25,949,236	3,829,224	6,191,723	752,361	11,725,438	5,534,298	4,120,999
Grand Total (1000 US$)	3,844	157	578	1,175	56,411	8,324	13,460	1,636	25,490	12,031	8,959

Table G.13 INCREMENTAL BENEFIT BY PROJECT

Project Title	Without Project Condition			With Project Condition			Incremental Production (ton)	Market price by crops (TShs/kg)	Incremental Benefit* (1,000 TShs)
	Planted Area (ha)	Yield (ton/ha)	Production (ton)	Planted Area (ha)	Yield (ton/ha)	Production (ton)			
Lower Ruvu									
1 Bagamoyo Irrigation Development									
Paddy	108	4.5	486	1,500	4.5	6,750	6,264	190	238,032
Maize		-		217	3.6	781	781	42	9,843
								Total 1	**247,875**
2 Low-lift Pump Irrigation									
Paddy	20	1.2	24	70	3.8	266	242	190	9,196
Maize	30	1.2	36	10	3.6	36	0	42	0
								Total 2	**9,196**
3 Makurunge Irrigation									
Paddy		-		200	3.8	760	760	190	28,880
Maize		-		30	3.6	108	108	42	1,361
								Total 3	**30,241**
4 Ruvu National Youth Rice Irrigation									
Paddy		-		300	3.8	1,140	1,140	190	43,320
Maize		-		40	3.6	144	144	42	1,814
								Total 4	**45,134**
Middle Ruvu									
5 Kidunda Irrigation System									
Paddy	0	-		18,770	3.8	71,326	71,326	190	2,710,388
Maize	0	-		6,260	3.6	22,536	22,536	42	283,954
								Total 5	**2,994,342**
6 Ngerengere Irrigation System									
Paddy	0	-		2,940	3.8	11,172	11,172	190	424,536
Maize	0	-		980	3.6	3,528	3,528	42	44,453
								Total 6	**468,989**
Upper Ruvu									
7 Uluguru Mountain East			65,600			65,600		140	2,755,200
								Total 7	**524,800**
8 Mlali									
Paddy		1.8	0	400	3.8	1,520	1,520	190	57,760
Maize	60	1.4	84	240	3.6	864	780	42	9,828
									67,588
9 Mgeta Plain (Mgeta System)									
Paddy		1.8	0	2,800	3.8	10,640	10,640	190	404,320
Maize		1.4	0	5,600	3.6	20,160	20,160	42	254,016
Cotton		1.6	0	2,800	2.4	6,720	6,720	70	141,120
								Total 9	**799,456**
10 Mgeta Plain (Mvuha System)									
Paddy		1.8	0	1,400	3.8	5,320	5,320	190	202,160
Maize		1.4	0	2,800	3.6	10,080	10,080	42	127,008
Cotton		1.6	0	1,400	2.4	3,360	3,360	70	70,560
								Total 10	**399,728**
11 Uluguru Mountain West			148,675			148,675	0	40	1,189,400
								Total 11	**1,189,400**

Incremental Benefit is calculated deducting production cost, transportation cost, etc.

Table G.14 WEIGHT TABLE FOR PRIORITY STUDY

Conformity with National Policy					Socio-economic aspect	
Long Term National Plan					**Population Served**	
1. Attaining self-sufficiency	◎2	○1	×0		Estimated population in the area	
2. Increasing agricultural diversification	◎2	○1	×0		more than 20,000	5
3. Providing raw materials for industry	◎2	○1	×0		more than 15,000	4
4. Production for Export	◎2	○1	×0		more than 10,000	3
5. Deriving from livestock resources	◎2	○1	×0		more than 5,000	2
Full Score	**10**				less than 5,000	1
National Irrigation Policy					Estimated population density (no./km2)	
1. Economic viability	◎2	○1	×0		more than 200	5
2. State farm considered ending	No state farm exist in the				more than 150	4
3. State farm to investor or	Study Area.				more than 100	3
smallholder's organization					more than 50	2
4. New project to private sector	◎2	○1	×0		50 to 0	1
5. Support to smallholder	◎2	○1	×0		**Full Score**	**10**
6. Strong request by farmer's group	◎2	○1	×0		**Accessibility**	
7. Independency from Gov. interventions	◎2	○1	×0		Distance from national trunk road (km)	
Full Score	**10**				Less than 5km	10
Project Ranking by ISID	Ranking top 10 %		10		5 - 10 km	8
	Ranking top 30 %		8		10 - 20 km	6
	Ranking top 60 %		6		20 - 50 km	4
	Ranking top 80 %		4		50 -100 km	2
	Others		2		more than 100km	1
Full Score	**10**				**Full Score**	**10**
Sub-Total 1	**30**				**Sub-Total 2**	**20**

Technical Aspect		Estimated Cost and Benefit	
Water Resources		**Total construction cost (million Tshs)**	
Stable water resources without condition	10	less than 500	5
Stable water resources with one condition	8	1,000 - 500	3
Stable water resources with two conditions	6	more than 1,000	1
Unstable water resources	4	**Full Score**	**5**
Full Score	**10**	**Cost per hectares (1,000 Tshs/ha)**	
Water Quality		less than 1,380	5
Suitable	3	1,380 - 2,300	3
Partly unsuitable	2	more than 2,300	1
Unsuitable	0	**Full Score**	**5**
Full Score	**3**	**Benefit per hectares (1,000 Tsha/ha)**	
Soil Condition		more than 10,000	5
Suitable	3	10,000 - 5,000	3
Unsuitable	0	less than 5,000	1
Full Score	**3**	**Full Score**	**5**
Easiness of project implementation		**B/C Ratio**	
On-going	4	more than 5	15
Existing	3	3 - 5	10
Planing Stage	2	Less than 3	5
Abondoned	1	**Full Score**	**15**
Full Score	**4**		
		Sub-Total	**30**
Sub-Total	**20**		

TOTAL SCORE = Sub-total (1+ 2 + 3 + 4) = 100

Table G.15 PRIORITY OF AGRICULTURAL PROJECT IN THE RUVU BASIN

	Item \ Project Title	1. Bagamoyo Irrigation Development Project	2. Pilot Farm Low-lift of Pump Irrigation Project	3. Existing Pump Irrigation Schemes Rehabilitation Project		4. Middle Ruvu Irrigation Project		5. Uluguru Mountain East Project	6. Mlali Irrigation Project	7. Mgeta Plain Irrigation Development Project		8. Uluguru Mountain West Project
		Lower Ruvu Valley				Middle Ruvu Valley		Upper Ruvu Valley				
			Low-lift Pump Irrigation Project	Makurunge Irrigation Project	Ruvu National Youth Irrigation Project	Kidunda Irrigation Project	Ngerengere Irrigation Project			Mgeta Plain Irrigation Project	Mgeta Plain Mvuha Irrigation Project	(Mgeta traditional irrigation)
General Feature of the Project	**Project Description**											
	Potential Area in Gross (ha)	1,000	2,400	150	800	26,500	3,500	16,000	800	25,000	5,000	2,000
	Proposed Project Size in Net (ha)	1,100 including area of private farm	50 5 nos. of pilot schemes	150	200	15,600	2,450	Potential area for the Area is estimated based on cultivation and production records	400	7,000	Potential area is estimated based on villager's information	2,000 Data from district office
	Present Status	Pilot farm of 100ha is under Construction	Small-scale irrigation by manpower	Abandoned	Farm exists but no irrigation since 1978	African Cultivation	African Cultivation	Existing "Fruit (Orange) Zone" Existing Area = 2,624 ha	Existing but no irrigation area because of siltation at weir site	Rainfed farming	Rainfed farming	Existing "Vegetable Zone" for Morogoro and DSM
	Prospective Project Component	Irrigation and Drainage system - Main Irrigation : 12 km - Secondary : 10 km - Drainage : 12 km Heightening of Lower Ruvu NUWA intake will be required for gravity irrigation.	Pilot farm construction : 100ha - 5 canals (0.5 km each) - Supply of Low-lift pumps - Construction of workshops - Training programmes to farmers	- Reconstruction of Pumping house - Re-excavation of canals Irrigation canal : 2 km	- 2 pumping stations - Rehabilitation of existing canal system for 24 ha - Construction of new canal system for 176 ha - Supply of machinery - Rehabilitation of Godown	Irrigation & Drainage Canals Main Irrigation : 51 km Secondary : 122 km Drainage : 124 km	Irrigation and Drainage canals - Main Irrigation : 11 km - Secondary : 17 km - Drainage : 14 km Construction of basic social infrastructures	Soil conservation : 16,000 ha Improvement of trunk rural road Bigwa - Mkuyuni : 37 km Storage godowns : 1 Sorting and packing facilities : 1	Irrigation and Drainage canals - Main Irrigation : 2 km - Secondary : 10 km - Drainage : 9 km - Intake Weir : L=50 m - Intake Facility	Irrigation and Drainage canals - Main Irrigation : 40 km - Secondary : 65 km - Drainage : 50 km Rehabilitation of rural road - Morogoro - Kisaki : 140 km	Irrigation and Drainage canals - Irrigation canals Main & Secondary : 53km - Drainage canals : 28km Intake Weir : 1 no. Rehabilitation of rural road - Mvuha - site : 15 km	Soil erosion control : 2,000 ha Rehabilitation of rural road Mlali - Langali : 15 km Langali - Nyandira : 5 km Improvement of irrigation canals 68 systems : 170 km Domestic piped water supply
Conformity with Government Policy	**Long Term National Plan**											
	1. Attaining self-sufficiency	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
	2. Increasing agricultural diversification	○	○	○	○	○	○	◎	○	○	○	◎
	3. Providing raw materials for industry	×	×	×	×	○	○	◎	○	○	○	○
	4. Production for Export	×	×	×	×	○	○	◎	×	×	×	◎
	5. Deriving from livestock resources	×	×	×	×	○	○	×	×	×	×	×
	National Irrigation Policy											
	1. Economic viability											
	2. State farm considered ending	-	-	-	-	-	-	-	-	-	-	-
	3. State farm to investor or smallholder's organization	-	-	-	-	-	-	-	-	-	-	-
	4. New project to private sector	×	×	×	×	◎	◎	×	○	○	×	×
	5. Support to smallholder	◎	◎	◎	×	○	×	◎	◎	○	◎	◎
	6. Strong request by farmer's group	◎	◎	○	×	×	×	○	◎	○	◎	◎
	7. Independency from Gov. interventions	○	○	○	×	◎	◎	○	○	○	○	○
	Project Ranking by ISID	No.1 out of 9 projects in Coast Region	Newly Identified Not yet included in the ranking	No.5 out of 9 projects	No.9 out of 9 projects	Newly Identified	Newly Identified	Newly Identified	No.5 out of 16 projects in Morogoro Region	Newly Identified	Newly Identified	No.3 out of 16 projects in Morogoro Region
	Weighted Sub-Total Score	18	12	13	5	15	14	16	18	12	13	20
Socio-economic Aspect	**Population Served**											
	Estimated population in the area	22,900	25,000	1,700	National Youth Service	5,200	5,200	45,000	12,200	29,500	8,100	32,600
	Estimated population density (no./km2)	280	150	30		15	15	140	150	70	100	100
	Accessibility											
	Distance from national trunk road (km)	9.5	10	10 (from Bagamoyo)	0.1	90	70	40	8 (3km form old trunk)	110	95	30
	Road condition in the Area	Accessibility is hard in the low-lying area for 2.5 km in flood season.	Access road is hardly passable in rainy season.	Road from BIDP to site is not passable in rainy season. The Ruvu river crossing by a ferry is required.	The project area is located besides the Morogoro - DSM Highway	Secondary rural roads connect the project area to a trunk road. Condition is seriously bad in rainy season	Secondary rural roads connect the project area to a trunk road. Condition is seriously bad in rainy season.	Major rural road "Morogoro - Kisaki" passes through the area. However, bad road condition is a serious constraint of the area.	Accessibility of this project is rather good.	Condition of the "Mkuyuni - Mvuha" section is serious in rainy season. Mngazi to Kisaki is not passable in rainy season.	Access road from Mvuha to the project area is not passable in rainy season.	Road in mountainous section of "Mlali - Nyandira" is seriously damaged. Section from Langali to Nyandira is not passable by a jeep.
	Weighted Sub-Total Score	18	17	10	10	5	5	12	15	9	7	12
Technical Aspect	**Water Resources**	**The Ruvu river** on following conditions - Construction of Dam(s) - Improvement of Lower NUWA intake weir or construction of new weir	**The Ruvu river** on following condition - Construction of Dam(s) for the whole potential area	**The Ruvu river** on following condition - Construction of Dam(s) for the whole potential area	**The Ruvu river** on following condition - Construction of Dam(s) for the whole potential area	**The Ruvu river** on following condition - Construction of Kidunda Dam	**The Ruvu river** on following condition - Construction of Ngerengere Dam	Mainly depend on Rainfall	**The Mlali river**	**The Mgeta river** on following condition - Construction of Mgeta Dam	**The Mvuha river** Hydrological data on the river is not available. Further study will be inevitable.	**The Mgeta river and small seasonal rivers and streams**
	Water Quality	Suitable for Irrigation	Water quality of the Mkombezi river is not suitable.	Suitable for Irrigation	Suitable for Irrigation	Suitable for Irrigation	Suitable for Irrigation	Suitable for Irrigation	Suitable for Irrigation	Suitable for Irrigation	Suitable for Irrigation	Suitable for Irrigation
	Soil Condition	*Suitable for Paddy*	*Suitable for Paddy*	*Suitable for Paddy*	*Suitable for Paddy*	*No data on suitability for cultivation*	*No data on suitability for cultivation*	*Suitable for most crops*	*Suitable for most crops*	*Suitable for most crops except north part of Gombo*	*Suitable for most crops*	*Suitable for most crops*
	Easiness of project implementation	On-going	Preliminary plan	Abondoned	Abondoned (no farming)	Preliminary plan	Preliminary plan	Existing	Existing	Preliminary plan	Preliminary plan	Existing
	Weighted Sub-Total Score	16	15	15	15	15	15	13	17	16	14	15
Economic Aspect	**Estimated Cost and Benefit**											
	Total construction cost (million Tshs)	1,768	72	265	540	25,949	3,829	6,192	752	11,725	5,534	4,120
	Cost per hectares (1,000 Tshs/ha)	1,630	1,442	1,771	2,702	1,658	1,563	2,360	1,881	1,675	1,581	2,060
	Benefit per hectares (Tsha/ha)	6,854	5,518	6,048	6,770	5,740	5,743	6,000	5,069	3,073	3,073	17,841
	B/C Ratio	4.20	3.83	3.42	2.51	3.46	3.67	2.54	2.69	1.83	1.94	8.66
	Weighted Sub-Total Score	19	21	21	12	17	17	12	14	12	14	26
Evaluation	**Total Score**	71	65	59	42	52	51	53	64	49	48	73
	Comments											
	Priority	A*	A	B	C	B	B	B	A	C	C	A

Note ; ◎ Fitted ○ Partly Fitted × Unfitted Priority A : Top Priority , A* : Top Priority with conditions , B : Priority , C : Low Priority

APPENDIX-G

FIGURES

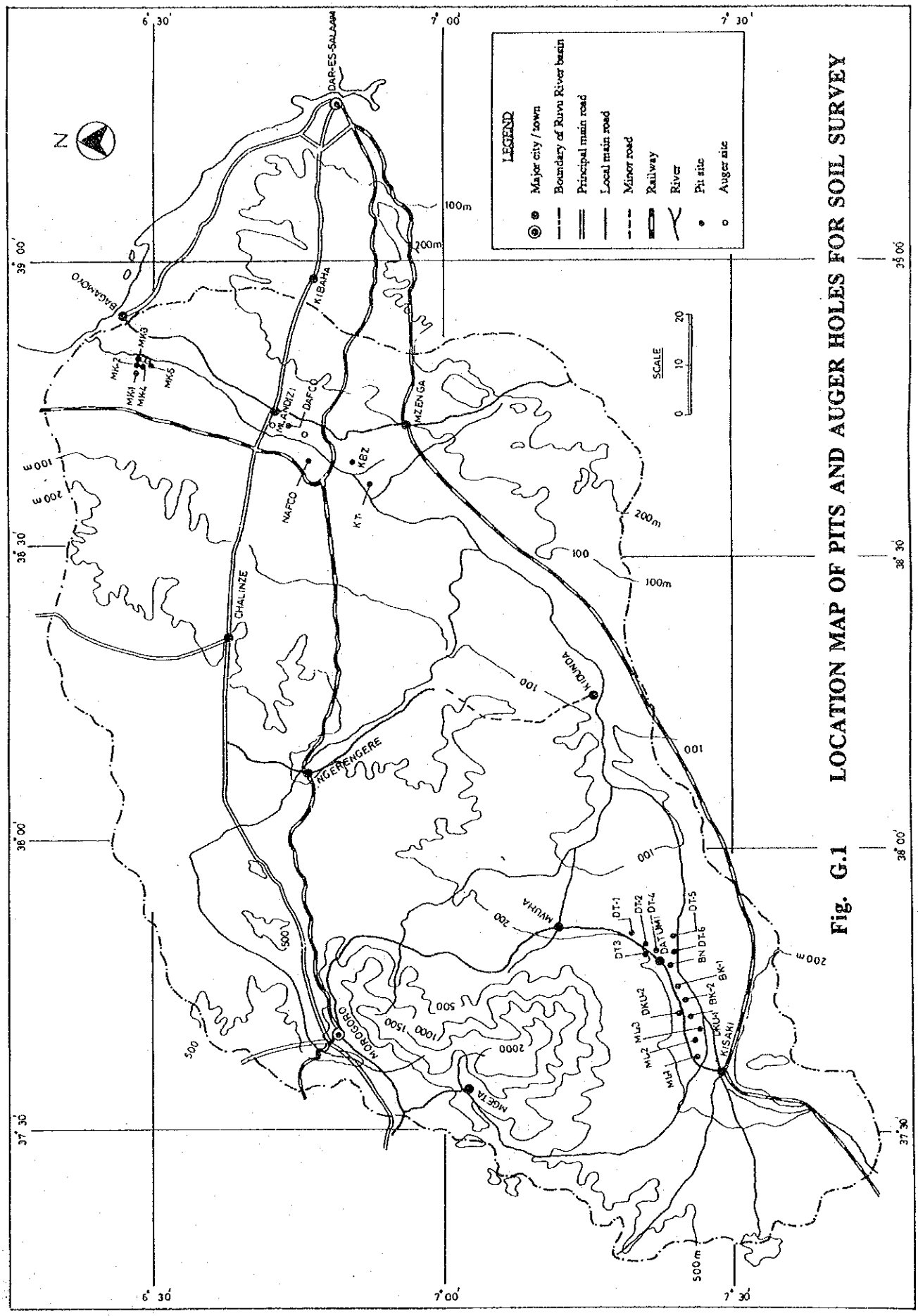


Fig. G.1 LOCATION MAP OF PITS AND AUGER HOLES FOR SOIL SURVEY

Fig. G.2 (1) PRESENT CROPPING CALENDAR : BAGAMOYO

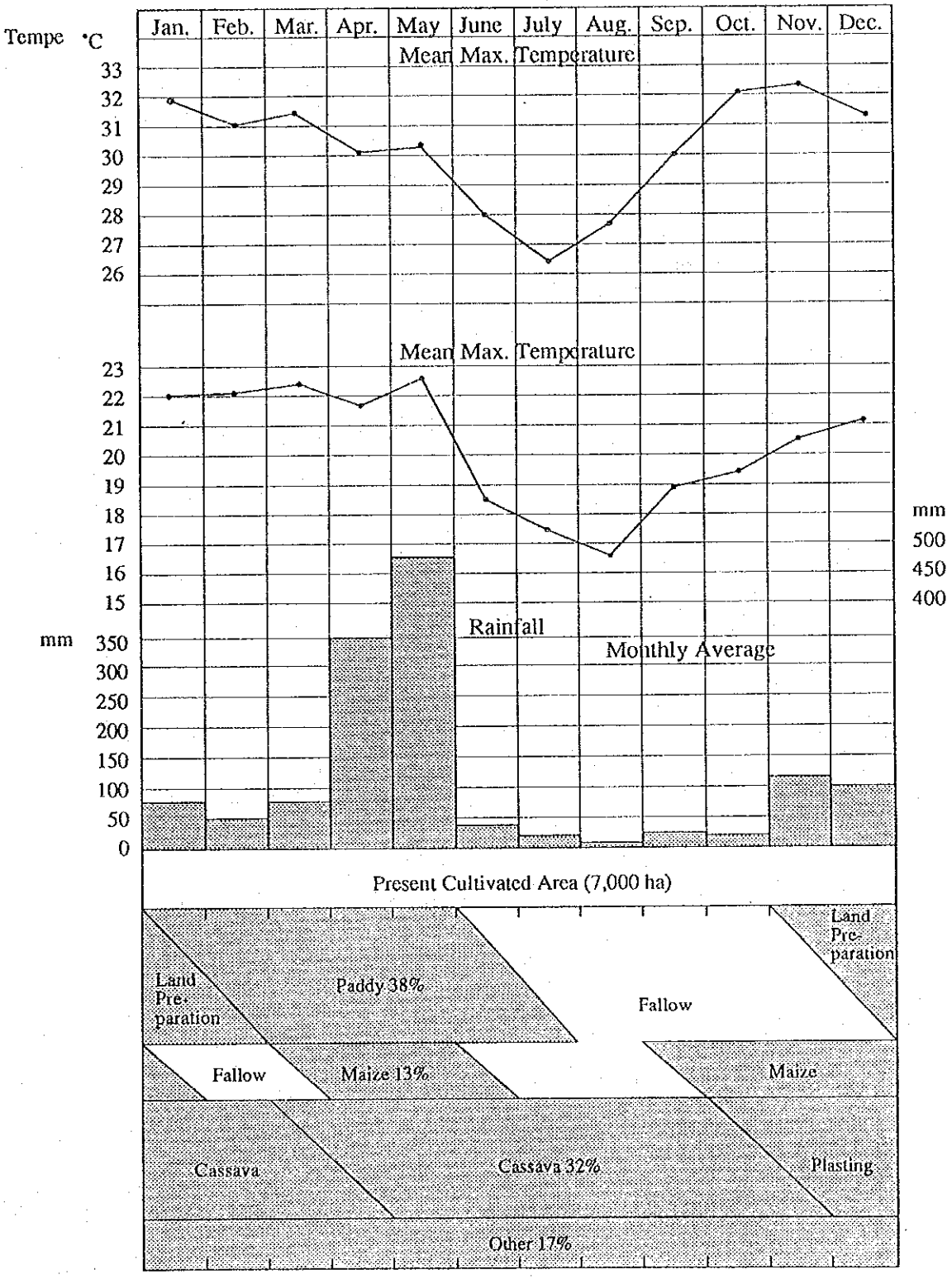


Fig. G.2 (2) PRESENT CROPPING CALENDAR : MKUYUNI

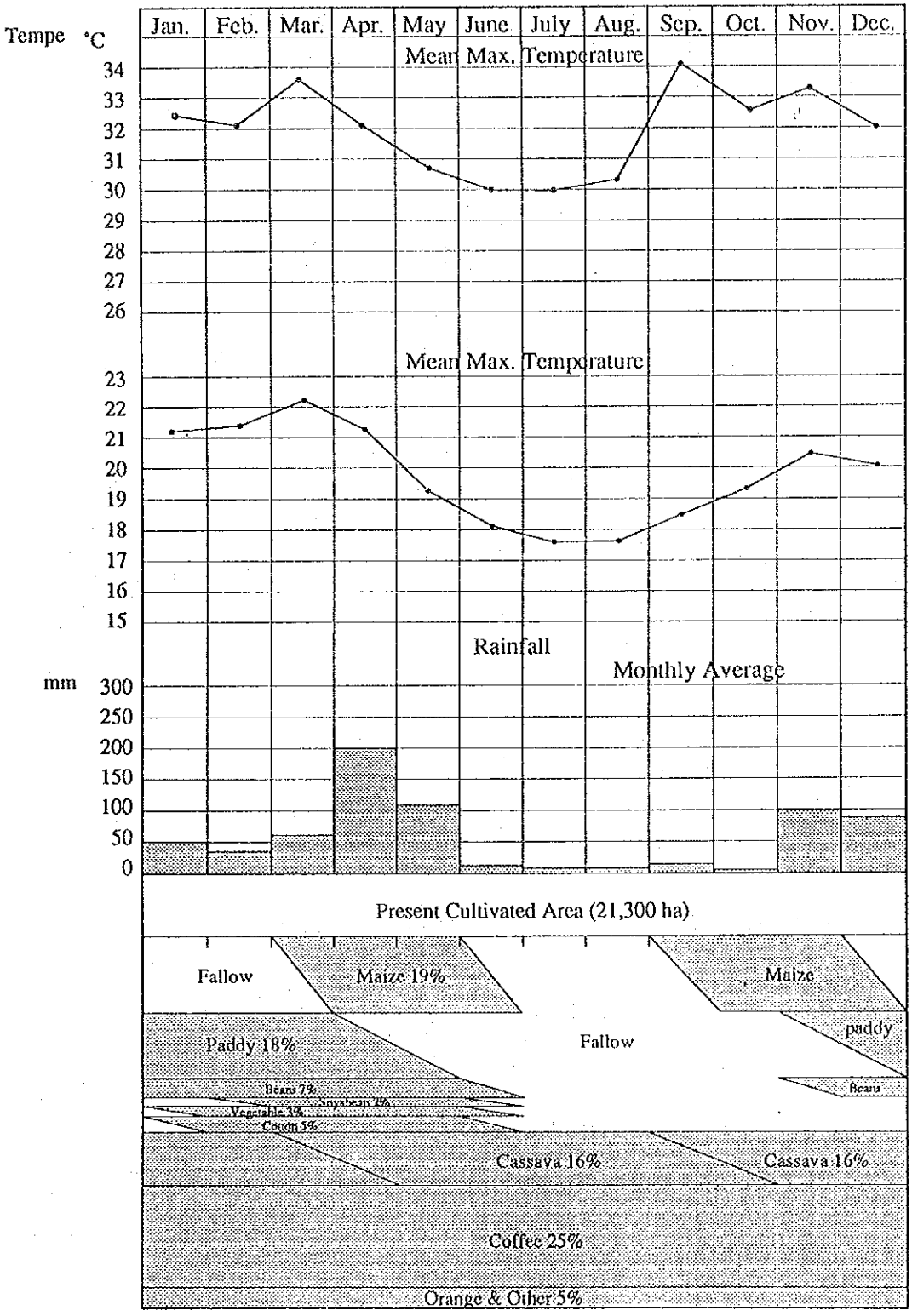


Fig. G.2 (3) PRESENT CROPPING CALENDAR : MGETA PLAIN

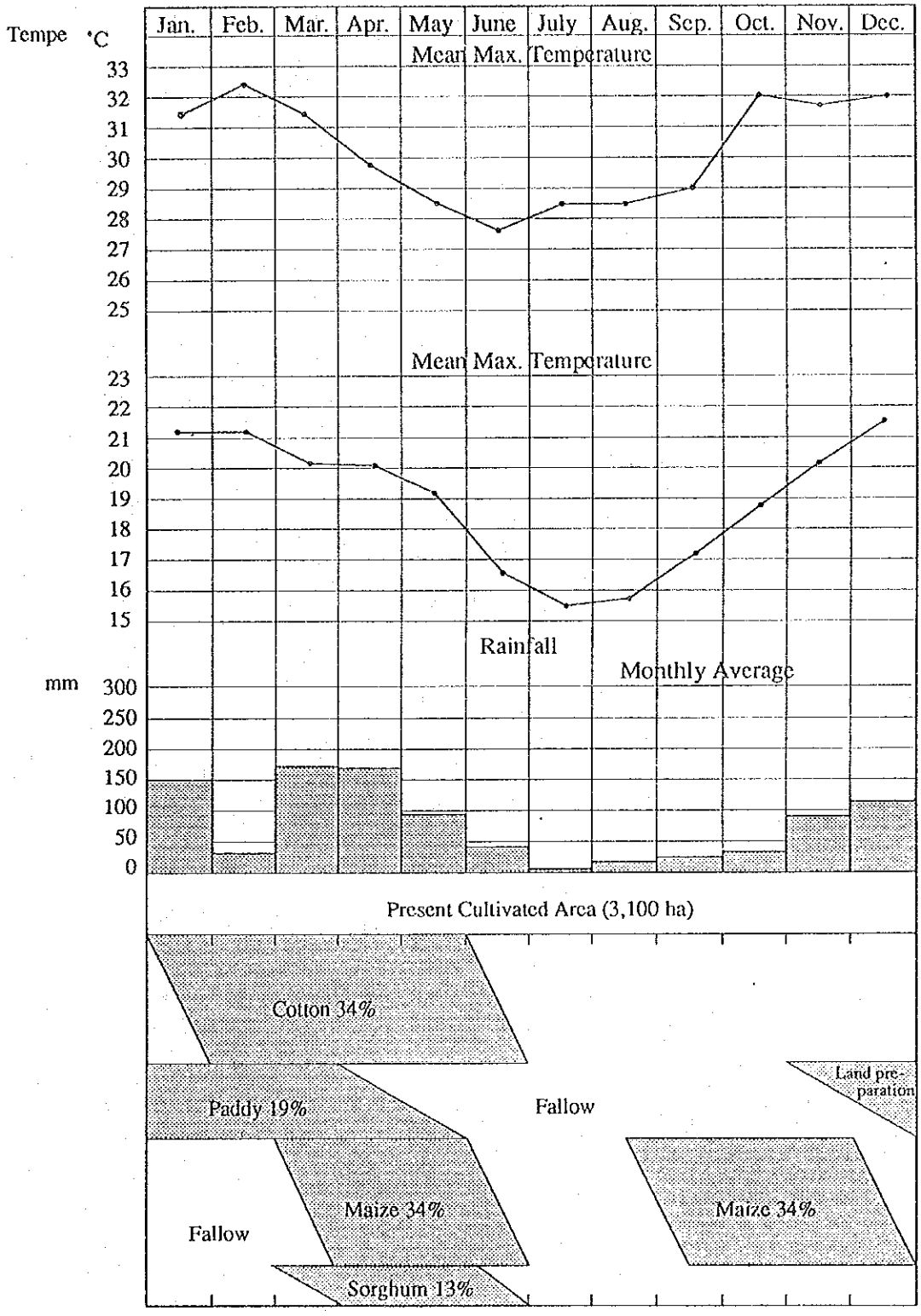
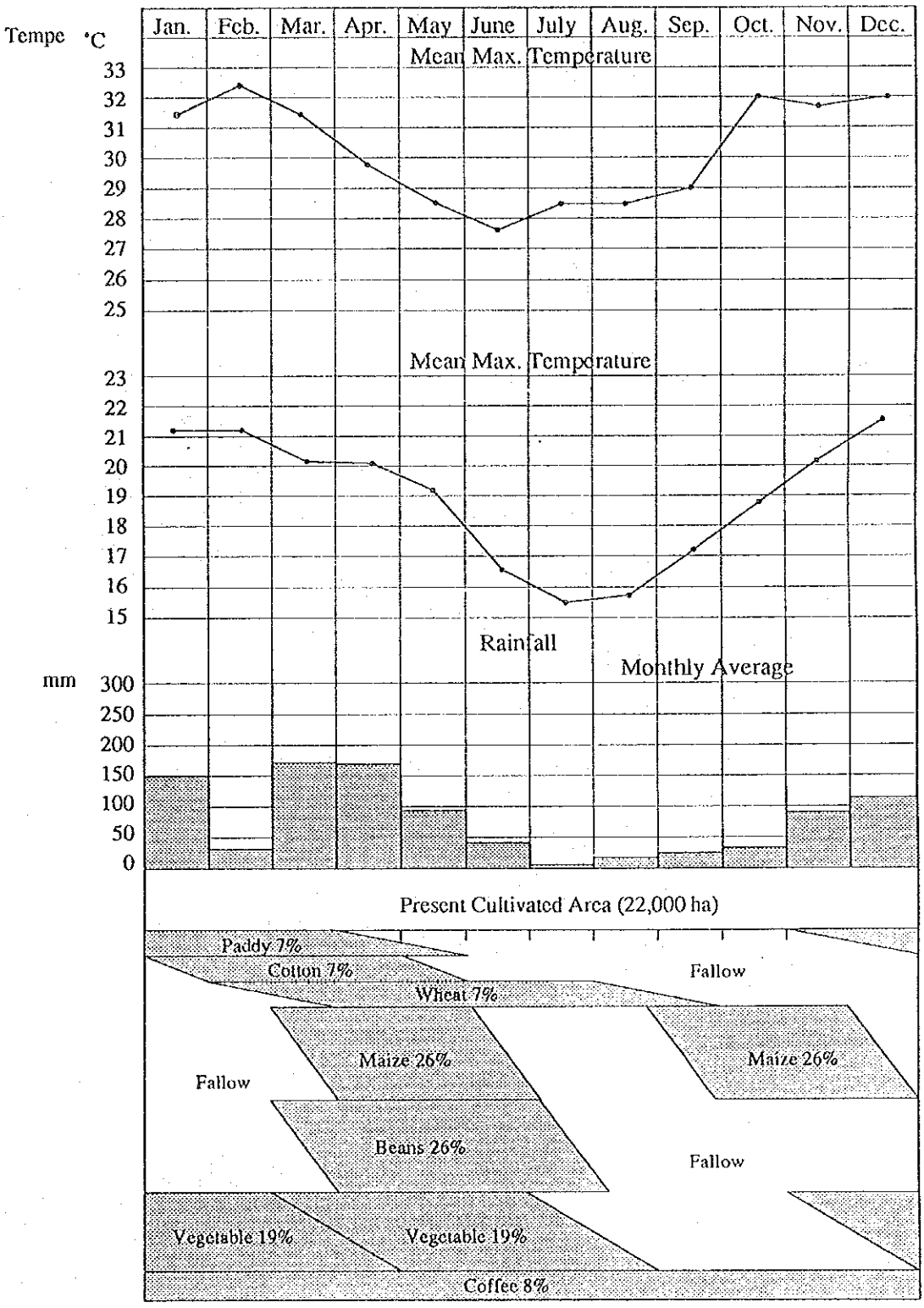
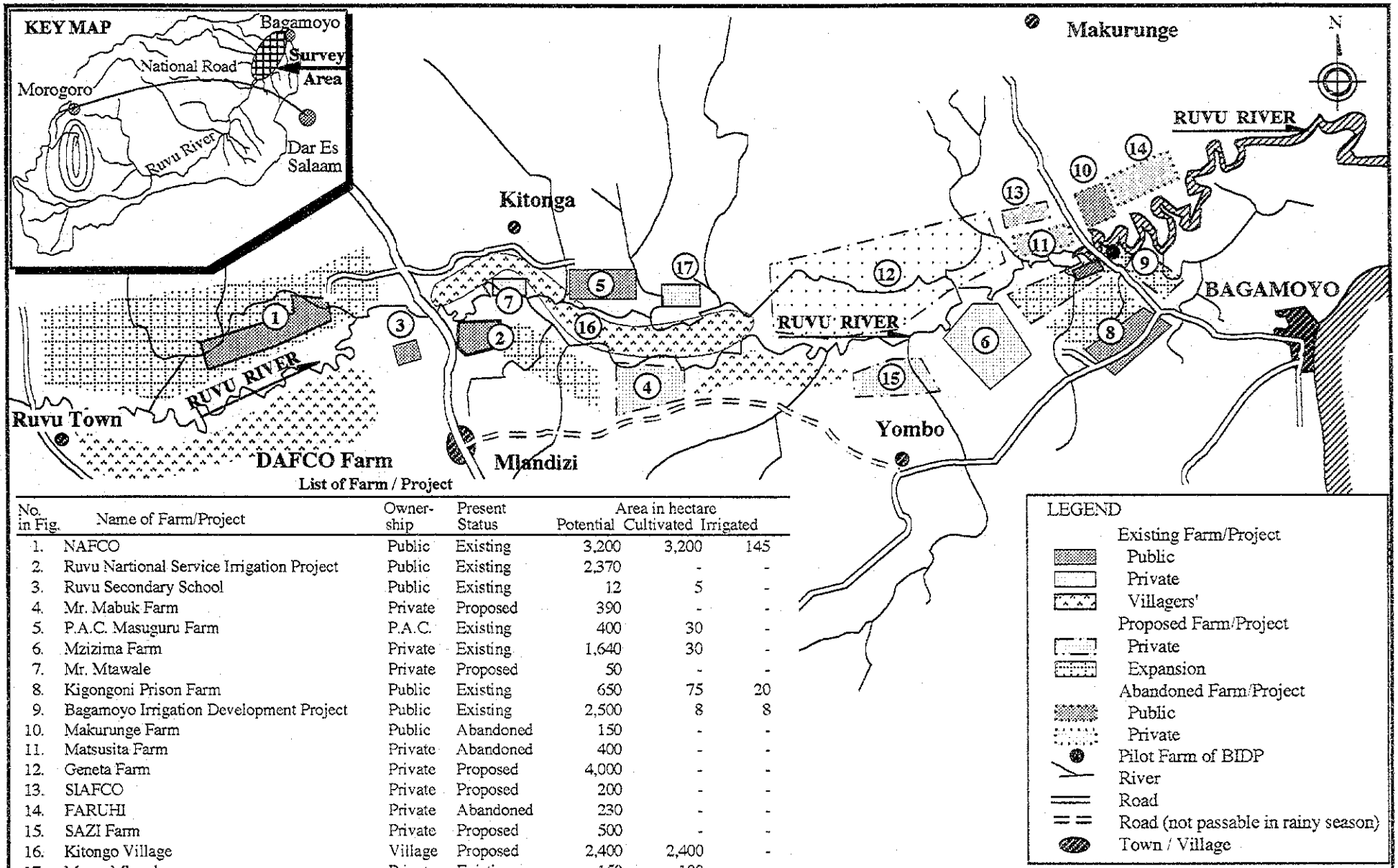


Fig. G.2 (4) PRESENT CROPPING CALENDAR : ULUGURU WEST





List of Farm / Project

No. in Fig.	Name of Farm/Project	Owner-ship	Present Status	Area in hectare Potential	Cultivated	Irrigated
1.	NAFCO	Public	Existing	3,200	3,200	145
2.	Ruvu Nartional Service Irrigation Project	Public	Existing	2,370	-	-
3.	Ruvu Secondary School	Public	Existing	12	5	-
4.	Mr. Mabuk Farm	Private	Proposed	390	-	-
5.	P.A.C. Masuguru Farm	P.A.C.	Existing	400	30	-
6.	Mzizima Farm	Private	Existing	1,640	30	-
7.	Mr. Mtawale	Private	Proposed	50	-	-
8.	Kigongoni Prison Farm	Public	Existing	650	75	20
9.	Bagamoyo Irrigation Development Project	Public	Existing	2,500	8	8
10.	Makurunge Farm	Public	Abandoned	150	-	-
11.	Matsusita Farm	Private	Abandoned	400	-	-
12.	Geneta Farm	Private	Proposed	4,000	-	-
13.	SIAFCO	Private	Proposed	200	-	-
14.	FARUHI	Private	Abandoned	230	-	-
15.	SAZI Farm	Private	Proposed	500	-	-
16.	Kitongo Village	Village	Proposed	2,400	2,400	-
17.	Mama Mhando	Private	Existing	150	100	-

Fig. G. 3 LOCATION MAP OF EXISTING / ABANDONED/ PROPOSED FARM AND PROJECT IN THE LOWER RUVU RIVER BASIN

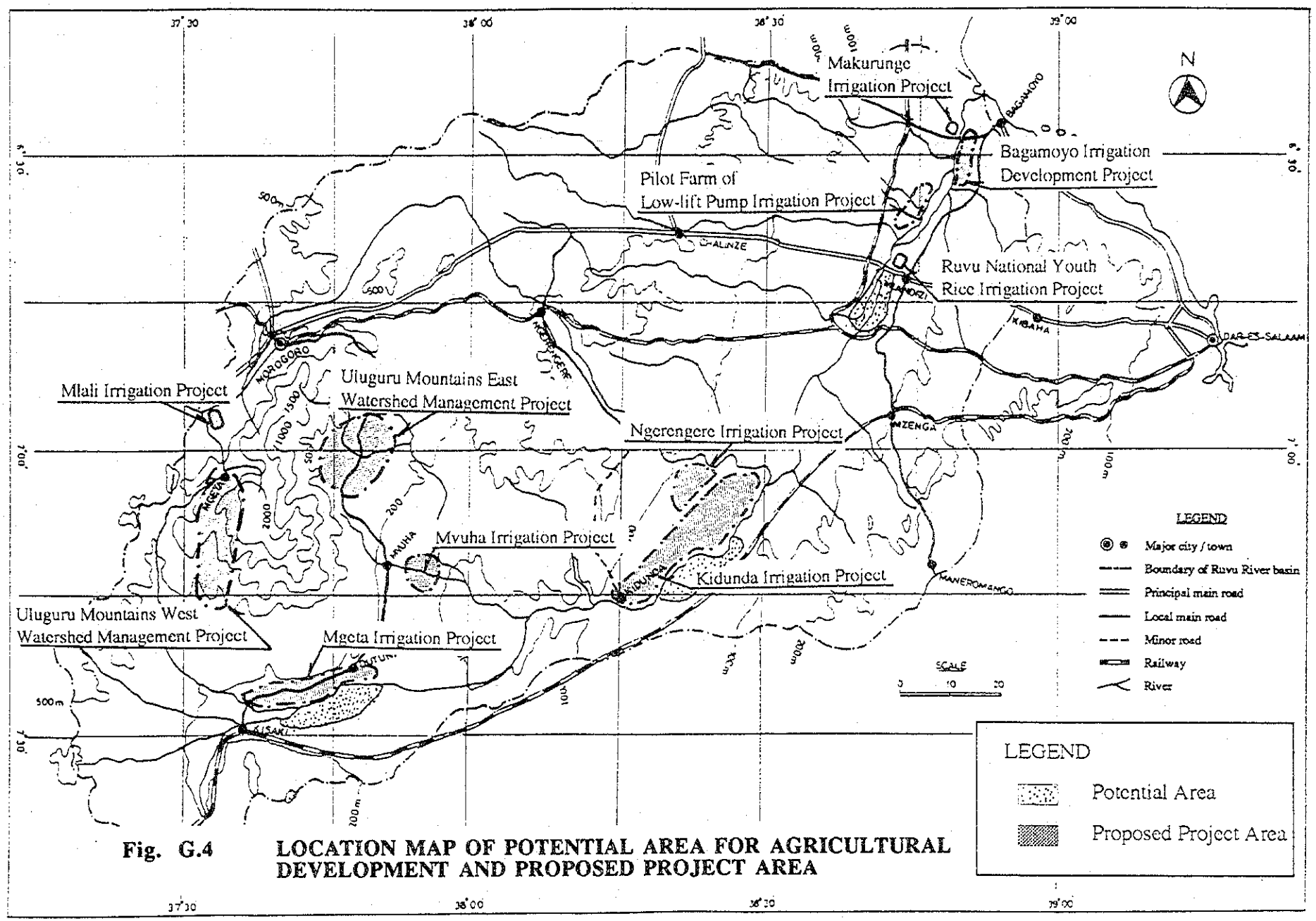


Fig. G.4 LOCATION MAP OF POTENTIAL AREA FOR AGRICULTURAL DEVELOPMENT AND PROPOSED PROJECT AREA

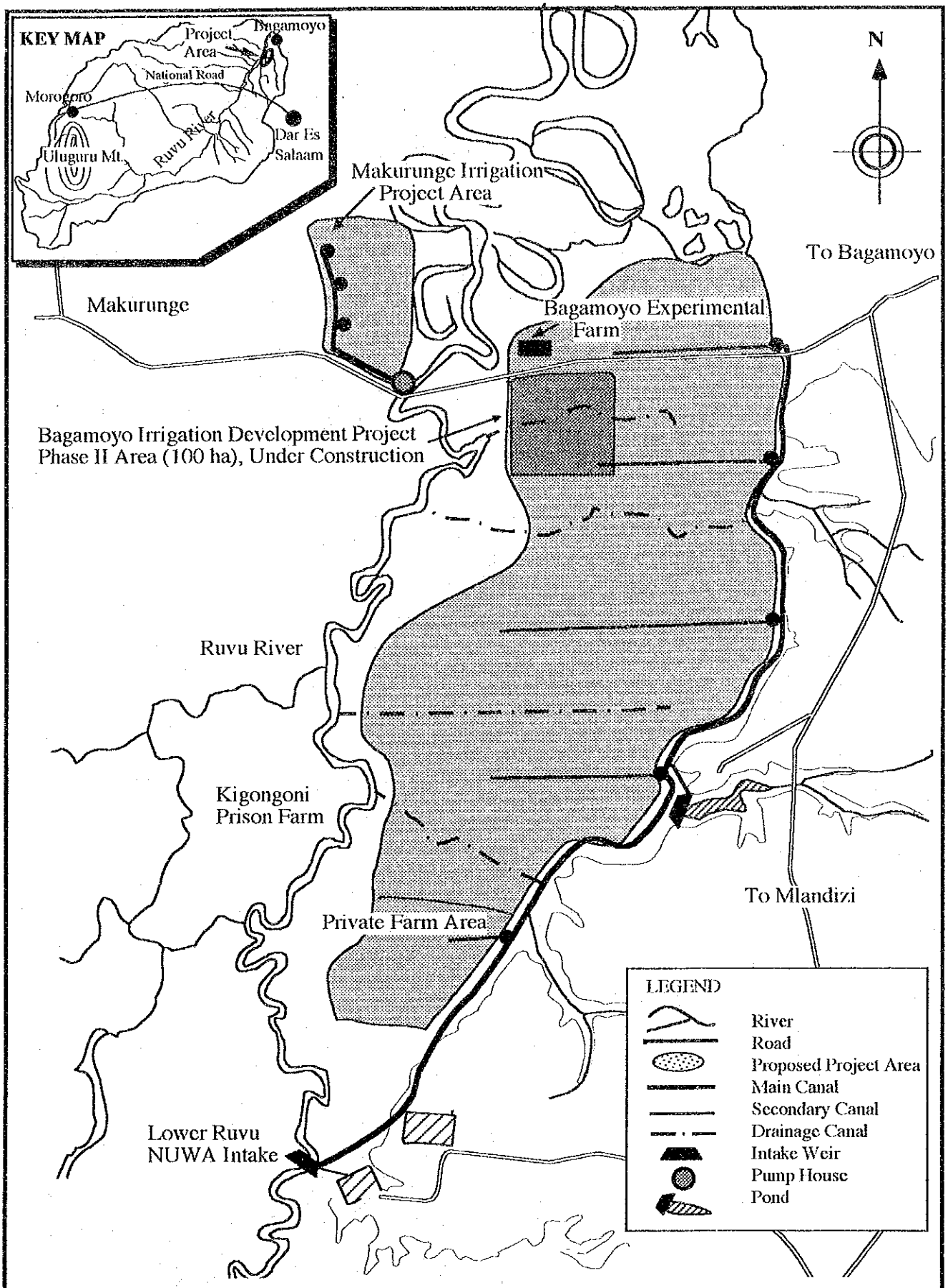


Fig. G.5 (1) GENERAL LAYOUT MAP OF BAGAMOYO IRRIGATION DEVELOPMENT AND MAKURUNGE IRRIGATION PROJECTS

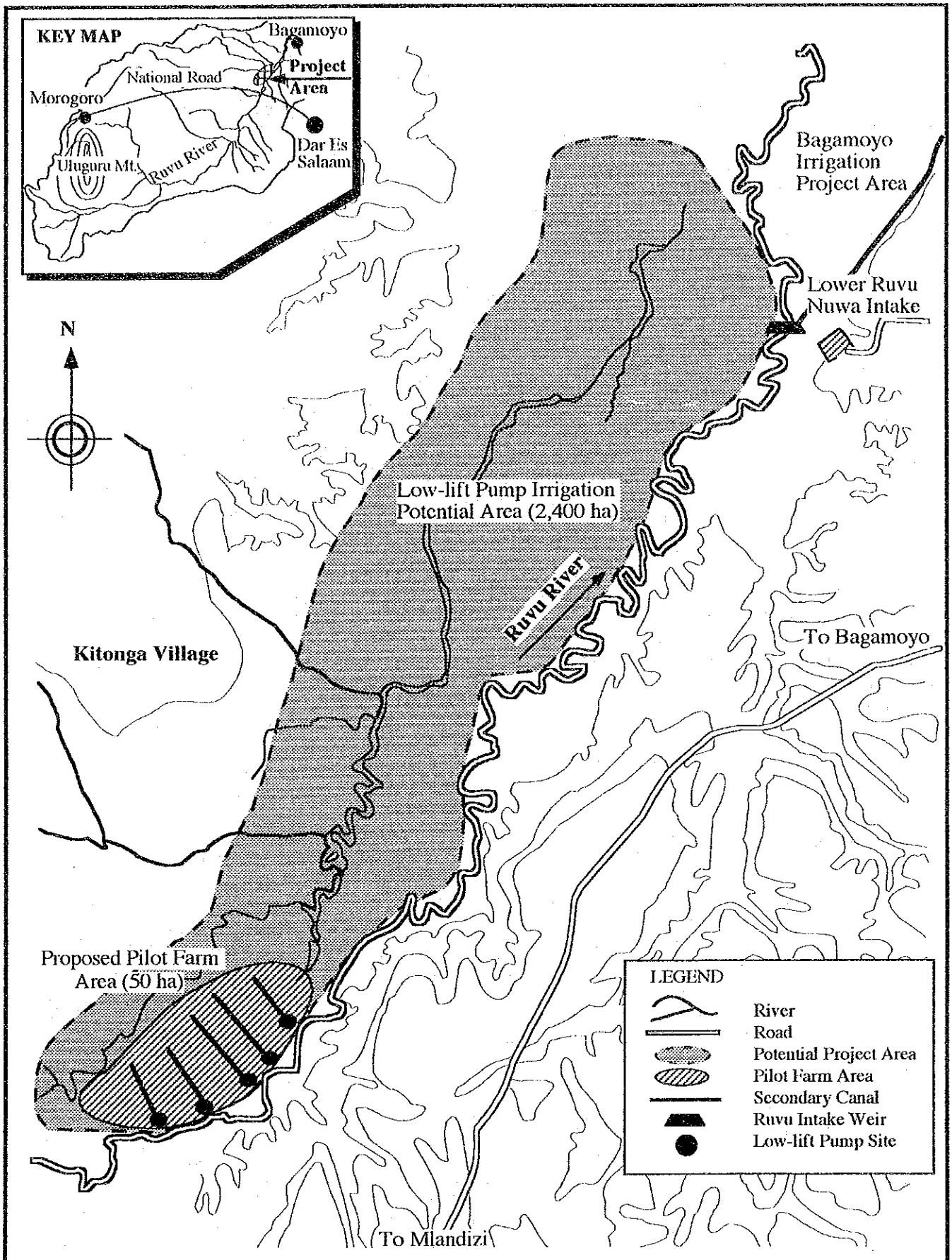


Fig. G.5 (2) GENERAL LAYOUT MAP OF THE LOW-LIFT PUMP IRRIGATION PROJECT

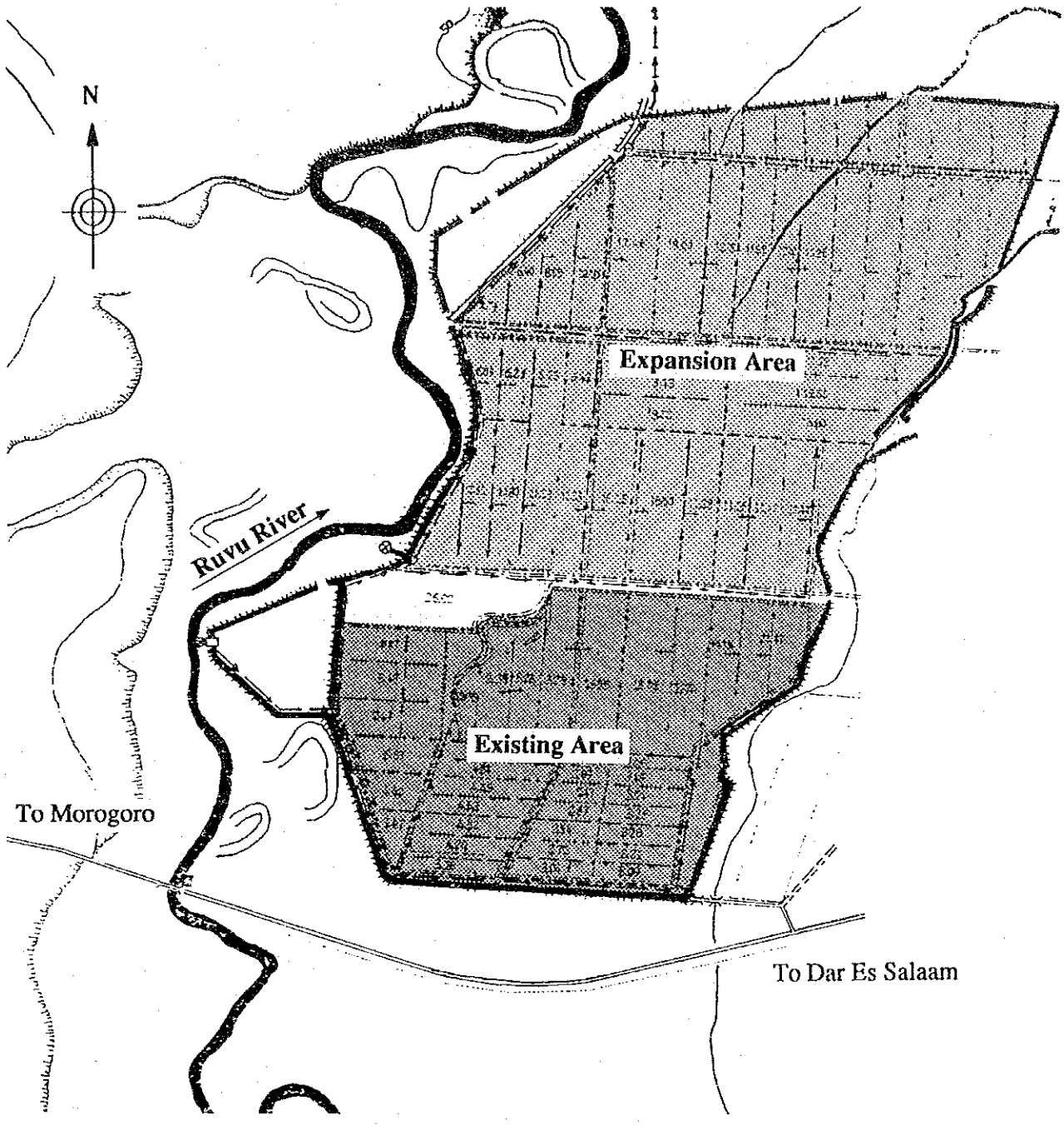


Fig. G.5 (3) GENERAL LAYOUT MAP OF RUVU NATIONAL YOUTH IRRIGATION PROJECT

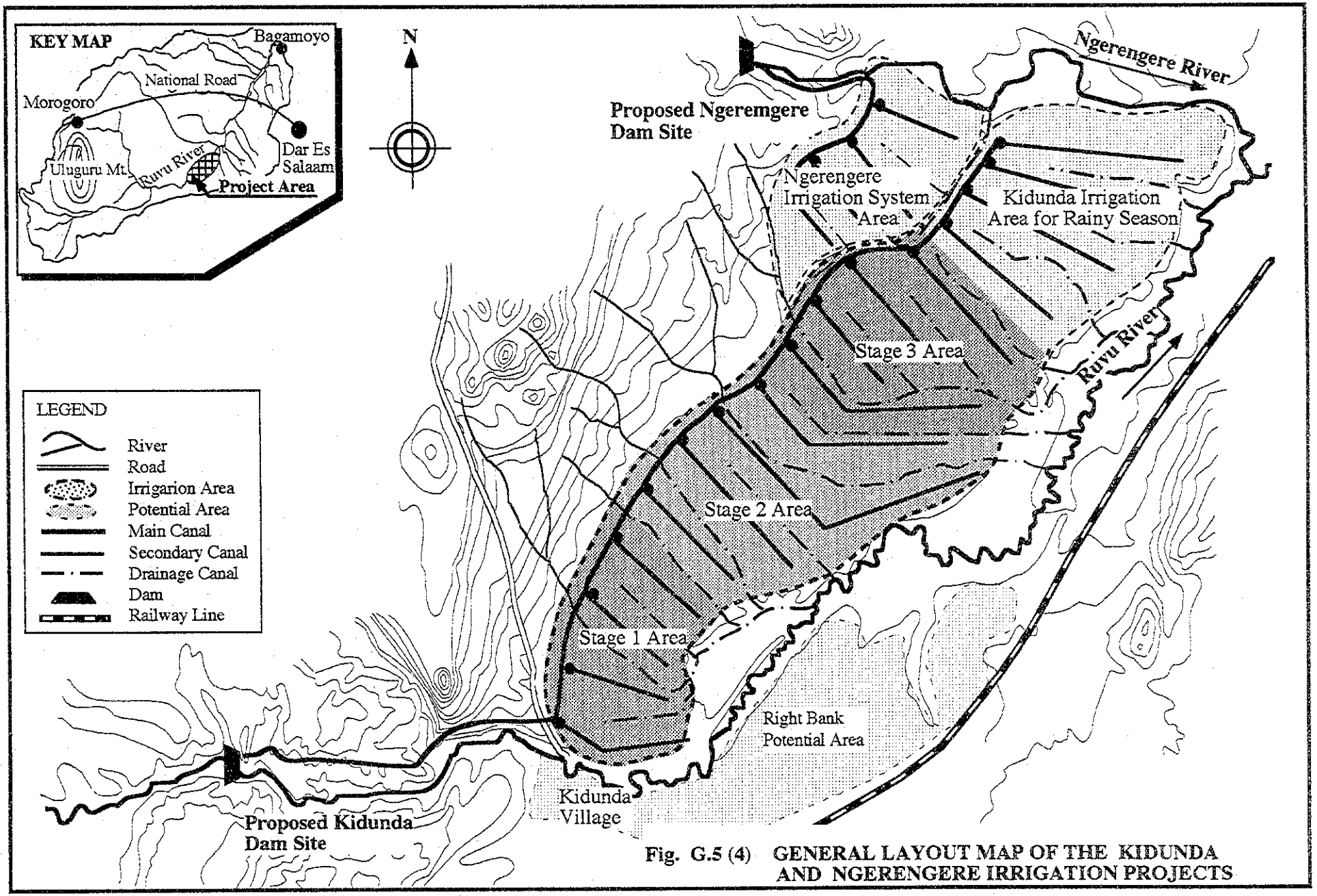


Fig. G.5 (4) GENERAL LAYOUT MAP OF THE KIDUNDA AND NGERENGERE IRRIGATION PROJECTS

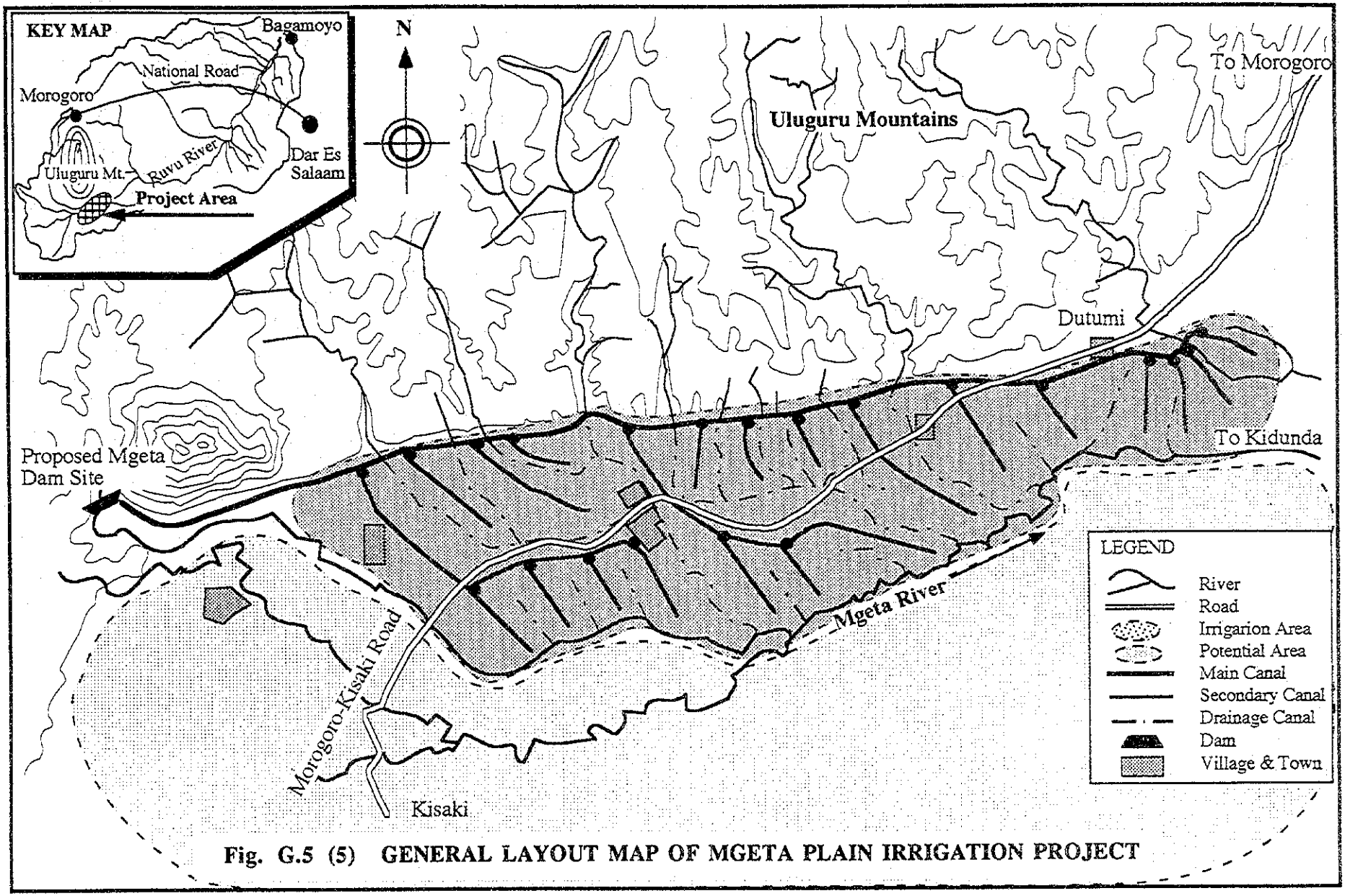


Fig. G.5 (5) GENERAL LAYOUT MAP OF MGETA PLAIN IRRIGATION PROJECT

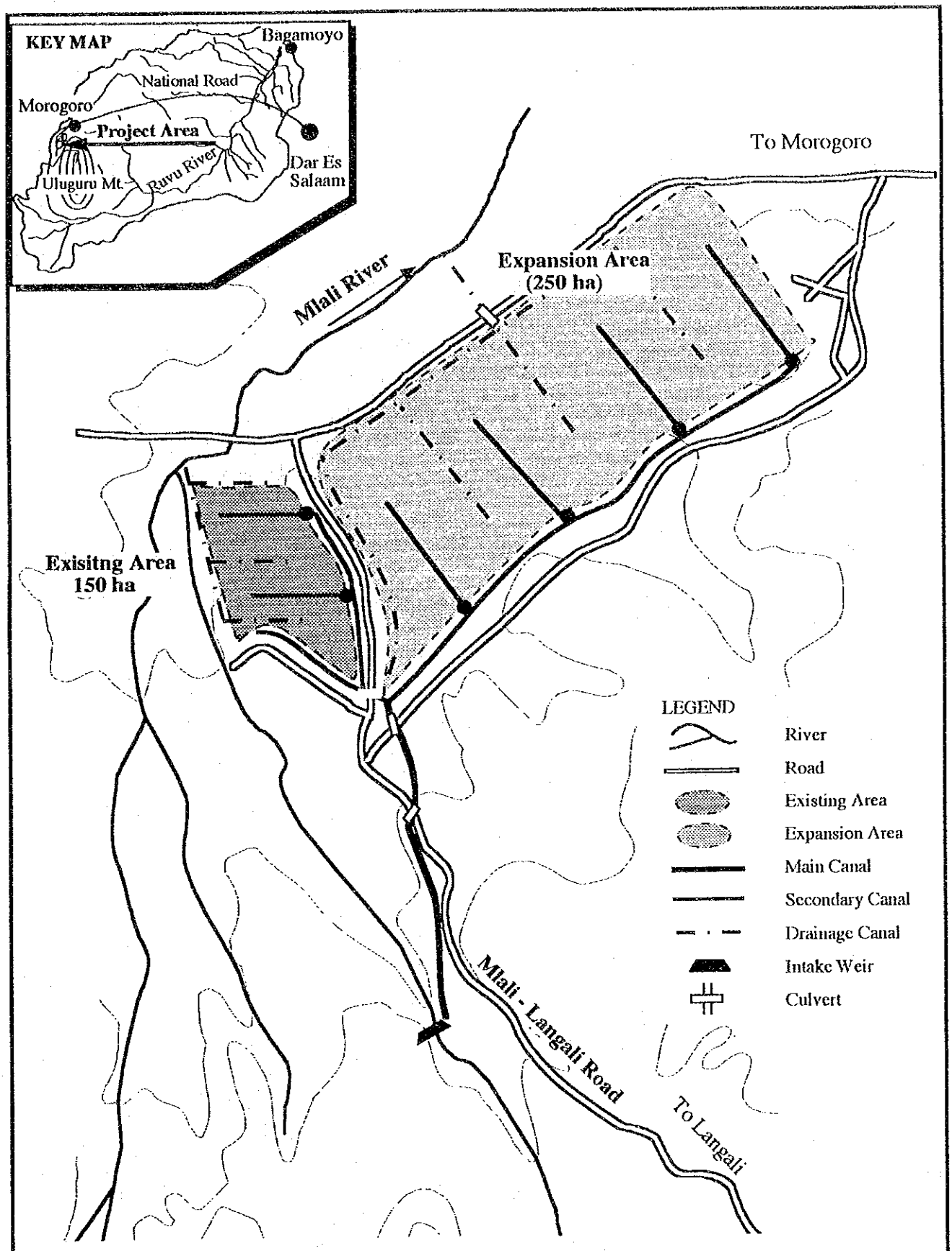


Fig. G.5 (6) GENERAL LAYOUT MAP OF MLALI IRRIGATION PROJECT

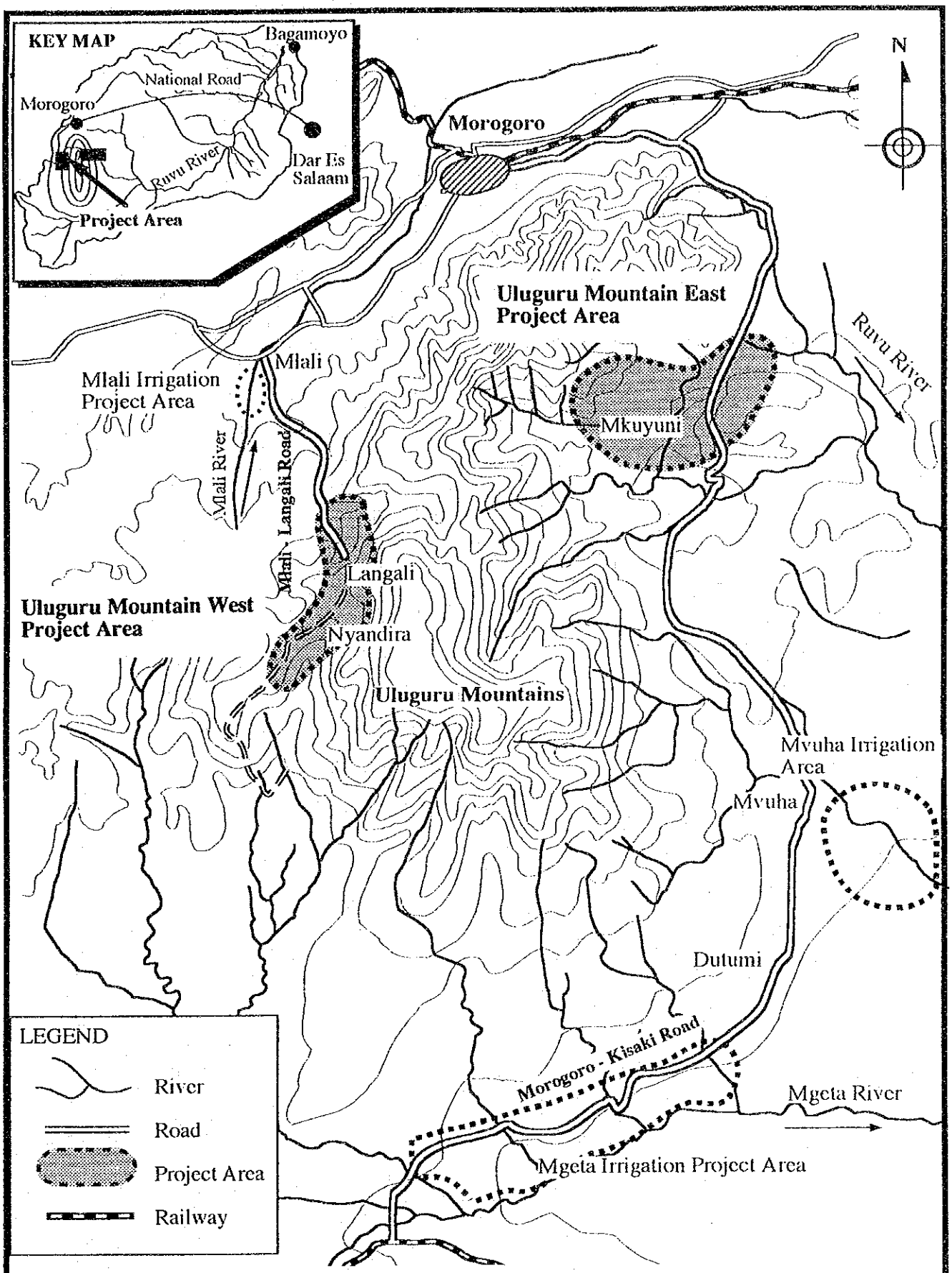
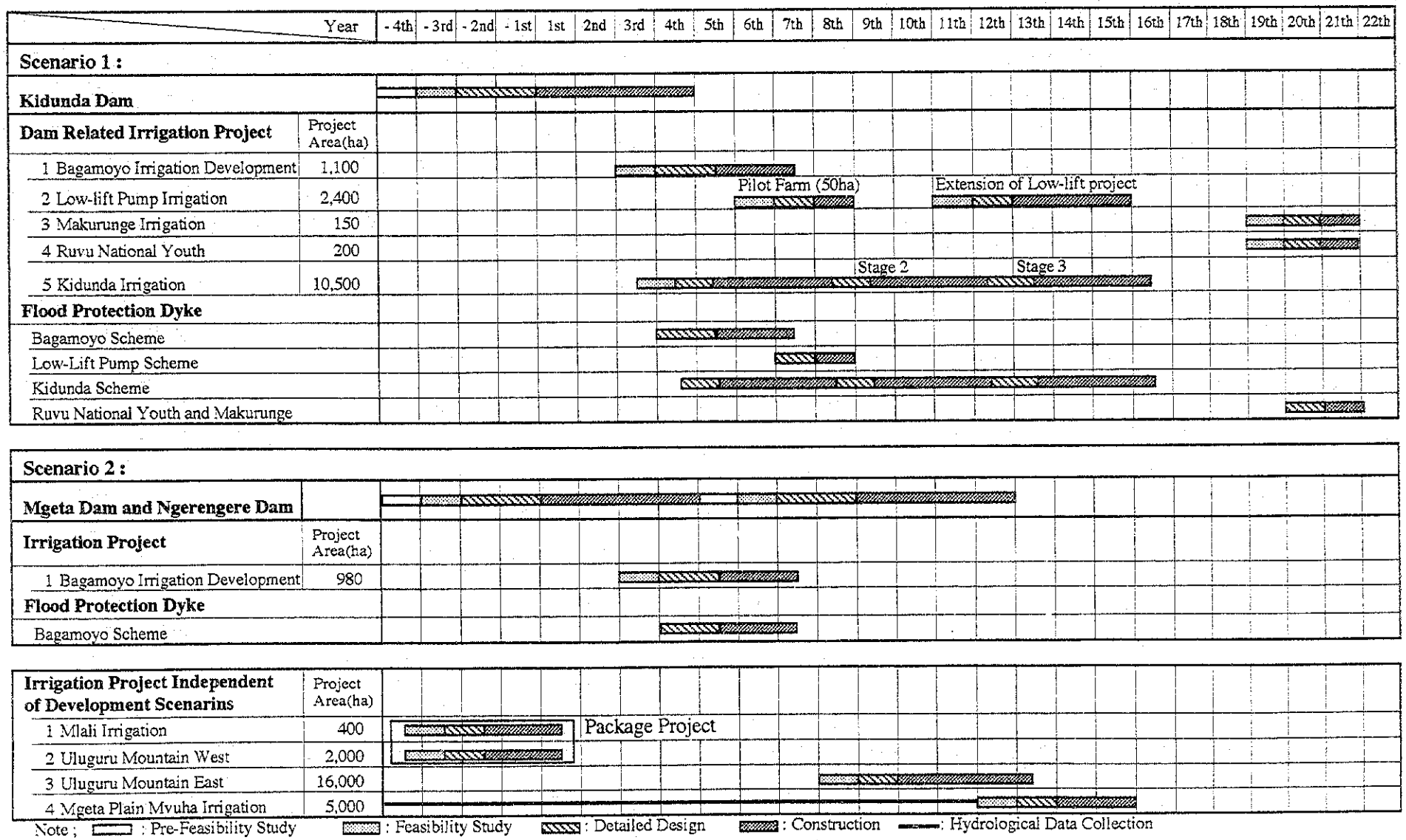


Fig. G.5 (7) GENERAL LAYOUT MAP OF ULUGURU MOUNTAIN WEST AND EAST PROJECTS

Fig. G.6 PROPOSED IMPLEMENTATION SCHEDULE OF IRRIGATION PROJECT BY SENARIOS



APPENDIX-G

REFERENCE

LIST OF REFERENCE (1/2)

Name of Data / Documents Reports / Publications	Souce of Data / Author / Publisher	Year/Date of Publication	Remarks
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An outline plan for the Development of the Ruvu Basin	FAO Expanded Technical Assistance Program No.1316	Jan., 1961	
Basic Data, Agriculture & Livestock Sector 1985/1986 - 1990/1991	Ministry of Agriculture, Statistics Unit, Planning & Marketing Division	May, 1992	
Coast / Dar es Salaam Regions Water Master Plan , Summary Volume, Vol. A, A-1, A-2, B, C and D	CIDA / CBA, Ministry of Water Energy and Minerals	Feb., 1979	Original
Coast Region Develpment Status			Copy : 9 pages
Geological Map of Coast Region (Showing Boreholes Drilled, Scale 1: 500,000)	Ministry of Water, Energy and Minerals		Blue Print
Geological Map of Dar Es Salaam (Showing Boreholes Drilled, Scale 1: 75,000)	Ministry of Water, Energy and Minerals		Blue Print
Geological Map of Morogoro Region (Showing Boreholes Drilled from 1931 to Sep. 1978, Scale 1: 500,000)	*Ministry of Water, Energy and Minerals*	1978	*Blue Print*
Geological Map of Tanganyika (1/2,000,000)	Geological Survey Department, Ministry of Mines and Commerce	1959	
Guidlines for Compiling Regional and District Afforestation Plans in Tanzania	Forest and Beekeeping Division	1985	
Household Budget Survey 1991/92 Vol. 1		Dec., 1992	
Hydrological Yearbook 1966 - 1970	Ministry of Water, Energy and Minerals		
Hydrological Yearbook 1971 - 1980	Ministry of Water, Energy and Minerals		
Institutional Responsibilities in Irrigation, Field Document No.13 (URT/86/012)	*FAO / UNDP, C.Chapman & E.H.* Masija, Ministry of Agriculture and Livestock Development	June, 1990	
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Master Plan for Morogoro	Ministry of Land, Housing and Urban Development	Mar., 1974	
Morogoro Region Five Year Development Plan 1984/85-1988/89 Vol. 2 "Developemnt Programmes and Identified Projects"	Morogoro Region Planning Commitee of Experts	Aug., 1984	Original 115 pages
National Accounts of Tanzania 1976 - 1991		Aug., 1992	
Population Census Regional Profile "Dar Es Salaam 1988"		Dec., 1990	

LIST OF REFERENCE (2/2)

Name of Data / Documents Reports / Publications	Souce of Data / Author / Publisher	Year/Date of Publication	Remarks
Population Census Regional Profile "Morogoro 1988"		Dec., 1990	
Proposal on Irrigation Development COAST REGION Five Year Plan 1986/87 - 1990/91	Rodgers L. Ishengoma		Copy : 20 pages
Report of the French Technical Mission for the Development of the Ruvu Basin	Sogreah	1962	
Ruvu Basin Present Irrigation Schemes and Future Development			Typescript 2 pages
Survey of Large Scale Farming Report Tanzania Mainland 1987/88	Bureau of Statistics, President's Office, Planning Commission	Dec., 1990	
Tanzania Vegetation Cover Types	The United Republic of Tanzania	1984	Map on a scale of 1: 2,000,000
The Five Year Union Development Plan 1988/89 - 1992/93 Agricultural Sector (Abstract)			Unofficial Translation from the Swahili version
Tree Planting in Tanzania : a Voice from Villagers	Forest Division	1983	
Trees for Village Forest	Forest Division	1984	

APPENDIX-H

FLOOD CONTROL PLAN

APPENDIX - H

FLOOD CONTROL PLAN

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APPENDIX - H

FLOOD CONTROL PLAN

1. PRESENT SITUATION OF RUVU RIVER SYSTEM

1.1 Characteristics of Rivers in the Study Area

All rivers in the Ruvu River basin are primitive and minor artificial works are provided mainly for the river crossing and water supply.

Except for the Uluguru Mountains area, the river slope is gentle and the extent of variation between high and low flows are so large that the rivers change their flowing channel at every flood causing the bank slope erosion.

1.2 Major Rivers and Their Longitudinal Profiles

The basin can be divided into 4 sub-basins, namely the Upper Ruvu, Mgeta, Ngerengere and Lower Ruvu. The about 370 km long mainstream of the Ruvu covers a catchment area of about 18,000 km^2, and its major tributaries are the Mgeta and Ngerengere Rivers. Their river systems are shown in Fig. H.1.

Longitudinal profiles of the major rivers with a river length of more than 20 km on the topographic maps at a scale of 1 to 50,000 are shown in Fig. H.2. According to these longitudinal profiles, most of the rivers have the gentle slope of less than 1% up to an altitude of about 200 m to 500 m. It deems that the rivers have been meandered tremendously by the large-scale floods. This is understandable through the comparison of the latest aerial photos and the topographic maps at a scale of 1 to 50,000 produced from the previous photos. The longitudinal river profiles are prepared based on the latest version of topographic maps.

1.3 Existing Reparian Structures and Water Uses

1.3.1 Land use

In the Study Area, most people settle at the eastern foot of the Uluguru Mountains, Morogoro Municipality in the Study Area located north of the Uluguru Mountains, and along the district roads on right bank side of lower Ruvu. Villages are scattered in the gently rolling hills in the central part of the Study Area. There are three major areas defined as the forest reserve areas in the Uluguru Mountains and in the right and left banks of the lower Ruvu. Less development was made previously in the basin, and it had been utilized mainly by sisal estates but most of them stopped their operation.

1.3.2 Reparian structures

Because of the aforesaid less development, there are only minor river-related works in the Ruvu River basin, such as river slope protection, short-cut and diversion works. The major river-related works are as follows;

Water Supply
NUWA's Upper Ruvu Intake : Ruvu River
NUWA's Lower Ruvu Intake : Ruvu River
Morogoro Water Supply (Mindu Dam) : Ngerengere River

Irrigation Intakes
(referred to in the next paragraph)

River Crossing Structures
- Ferry
Kikongoni ferry: : Ruvu River
- National highway
CST-1 : Dar Es Salaam - Chalinze
Morogoro Road Bridge : Ruvu River (Steel Truss, 3 spans, 103.5 m long)
(There are other many small span RC bridges and culvert)
CST-2 : Chalinze to Morogoro boarder
Bridge for Morogoro Road : Ngerengere River (Steel Girder, 1 span, 13.85 m long)
MOR-1 : Morogoro Region boarder to Morogoro
Morogoro Road Bridge : Ngerengere River (Steel Girder, 1 span, 23.87 m long)
Bridge for Morogoro Road : Musa River (RC, 3 spans, 14.95 m long)
MOR-2 : Mikumi junction to Morogoro
Bridge for Mikumi Road : Ngerengere River (RC girder, 1 span, 13.72 m long)
(There are many other small culverts on tributaries.)
MOR-3 : Morogoro to Dodoma boarder
Bridge for Dodoma Road : Ngerengere River (RC girder, 1 span, 20.36 m long)
(There are many other small culverts on tributaries.)
District Roads
Kibungo Bridge : Ruvu River
(There are other small bridge culverts on tributaries.)

1.3.3 Water use

(1) Water right

The Water Utilization Act of 1974 and amended Water Utilization Act of 1981, which were enacted by the Tanzanian Government, control the utilization of water resources. According to the Declaration of Water Basins on January 13, 1989, the Ruvu River basin belongs to the Ruvu/Wami River Basin. The basin board of the Ruvu/Wami Basin has not yet been established at present. Therefore, the water right in the basin is managed by the office of Principal Water Officer .

According to the office of Principal Water Officer, there are 115 water rights granted in the Ruvu River basin as shown in Table H.1. No monitoring works of granted water rights were done, and there are many grantees who are not extracting the river water, such as sisal estates which are not functioning. In addition, many people who are not registered in the water office are extracting or polluting the river water at present.

(2) Water use

The maximum extraction discharge of water right grantees is estimated at 9.4 m^3/sec and the sources and purposes of their water was are summarized in Tables H.2 and H.3, respectively. The main water user is NUWA, being entitled to extract the maximum water of 4.2 m^3/sec, which is equivalent to 45 % of the total water amount of granted water rights in the basin.

There are several irrigation projects in the Study Area. However, the most of these projects are not functioning well at present because of insufficient fund or poor operation activity. They are as follows;

- Milali Irrigation Project
- Bagamoyo Irrigation Development Project
- Sugarcane Breeding Station
- Kitangali Seed Farm
- United Farming Co., Ltd.
- NFCO Farms (Dakawa and Ruvu)
- Estates (Msolwa and Patel)
- Ruvu National Youth Service Farm
- Prison Farms (Kikongoni, Mbigili and Idete)

1.3.4 Salt water intrusion

According to the tide observation at Mbegani by the Study Team in April and May 1993, the spring high tide rises to 2.3 m, while the ground elevation at the BIDP farm is estimated at 2.3 to 2.5 m. Therefore, downstream part of the BIDP farm would be submerged by the spring high tide. But the electrical conductivity (EC) at BIDP pumping station showed around 350 μS/cm, or equivalent to 225 mg/litre of total soluble salts (TSS), implying no significant salt intrusion thereat. The effect of high tide level at the river mouth seems to be considerably diminished at the BIDP site, about 24 km upstream of the river mouth with mangrove forest. Besides, it stops perfectly by the fixed weir of NUWA's Lower Ruvu intake which has a crest elevation of about 3.27 m. Hence, the salt water intrusion would not influence on the proposed agricultural development area.

On the other hand, the water of the Msumbiji River shows high concentration of salinity (EC ranging between 1,500 and 2,100 μS/cm was observed in October, 1993). This phenomena might be caused by the salinity of ground water in the tributaries of the lower Ruvu left bank side. The same phenomena occurs at Pangani Dam (EC at 3,635 μS/cm in October, 1993) on the tributary of the lower Ruvu right bank side.

Based on these observations, it is possible to conclude that salt water intrusion is not a critical problem for water resources development, such as irrigation and domestic water supply, in lower reach upstream of the BIDP farm. But careful consideration needs to taken for water utilization in tributaries of lower reach of the Ruvu River because concerning their salinity.

2 FLOOD CHARACTERISTICS OF THE RUVU RIVER

2.1 Previous Large-Scale Floods

2.1.1 Flood peak discharge

According to the Hydrological Yearbooks and gauge records published by MWEM, the Ruvu River at gauging stations IH8 (Morogoro Road Bridge) marked the following large scale floods

after 1965, which were estimated to be mostly over 500 m^3/sec based on the rating curve newly constructed by the Study Team;

Year	Month	Estimated Discharge (m^3/sec)	
1967	December	720	(589)
1968	April	975	(754)
1973	May	433	(637)
1974	May	513	(835)
1978	December	611	(602)
1979	April	2,901	(1,094)
1984	June	604	(852)
1990	April	n.a.	(693)
1993	April	n.a.	(820)

Note: Number shown in above parentheses is the peak discharge estimated by the rating curves revised by the Study Team and through field interviews by the Study Team.

2.1.2 Specific peak discharge of flood

As described in Appendix-C of this Supporting Report, the average runoff coefficients in the mountainous area of the basin are more than 50 %, but it becomes very low in the lower reach. The gauging station 1H8 shows a runoff coefficient of about 12 %. Specific peak discharges of the maximum floods at the gauging stations in the lower Ruvu are very low as shown below;

Station No.	Catchment Area (km^2)	Maximum Q(m^3/Sec)	Specific Discharge F(m^3/sec/km^2)	Creager's C *
1HB2	85	10	0.117	3.51
1H5	420	157	0.374	6.35
1HB1	963	51	0.053	0.73
1HA5	1,646	54	0.033	0.60
1HA15	2,370	156	0.066	1.48
1HA1	2,840	63	0.022	0.55
1H10	5,870	877	0.149	5.73
1H3	6,697	699	0.104	4.34
1H8	15,190	1,094	0.072	5.04

Note : * ; Creager's coefficient estimated by the following Creager's equation;

$$F = 46\, C \cdot A^{(0.894X - 1)}$$
$$X = A - 0.048$$

where, F : specific discharge ($feet^3$/sec.)
C : creager's C value
A : catchment area (square. miles)

2.2 Flood Characteristics in 1973

2.2.1 Peak flood discharges

In order to analyze the flood characteristics of the Ruvu River, the flood in 1973, on which the complete hydrological data at 1H5, 1H10, 1HA1A and 1H8 are available, is selected to compare the hydrographs observed. The peak discharge and catchment area of each gauging station are as follows;

Station No.	Name	Catchment Area(km^2)	Peak Discharge (m^3/sec)	Specific Discharge (m^3/sec)
1H5	Kibungo	473	171	0.361
1H10	Mikula	5,870	646	0.110
1HA1A	Utari Bridge	2,840	61	0.022
1H8	Morogoro Road Bridge	15,190	637	0.042

2.2.2 Hydrographs of gauging stations

Based on the mean daily discharge estimated by the stage-discharge rating curve revised by the Study Team, each hydrograph is plotted as shown in Fig. H.3, which show that:

- Peak discharge was cut between 1H10 (646 m^3/sec) and 1H8 (637 m^3/sec).
- Receding slope of the hydrograph at 1H10 is slightly steeper than that at 1H8.

Referring to the peak discharges and receding slopes of hydrographs at 1H10 and 1H8 as well as the topographic condition, it is understood that floodplain along the Ruvu River between 1H10 and 1H8 functions as a retarding basin. The natural retarding basins in the Study Area were identified in the other areas based on the existing topographic maps and field reconnaissance. They are, shown in Fig. H.4 and summarized below;

- Kidunda Plain : area along the Ruvu River between the proposed Kidunda dam site and confluence with the Ngerengere River
- Mgeta Plain : area along the Mgeta River between the proposed Kidunda reservoir and Kisaki
- Ngerengere Plain : area along the Ngerengere River between the proposed Ngerengere dam and Ngerengere town
- Morogoro Plain : area along the Ngerengere River near Morogoro municipality

2.3 Present Flow Capacity of the Ruvu River

2.3.1 Flow capacity

The present flow capacity of river channel was estimated in order to clarify the full bank flow capacity of low water channels in the lower Ruvu. The estimation was made applying the water level to the stage-discharge rating curves at the gauging stations and by means of the non-uniform flow analysis for the lower Ruvu.

2.3.2 Flow capacity of Lower Reaches of the Ruvu

The flow capacity of low water channel in the lower Ruvu floodplain was estimated through the non-uniform flow analysis. The non-uniform flow analysis is described in the succeeding Section of this Appendix-H. As a result of the estimation, the low water channel capacity in the reach varies between less than 100 m3/sec near the Kikongoni ferry site and 300 m3/sec near the Morogoro Road Bridge. They are shown in Table H.3 and Fig. H.5.

2.3.3 Flow capacities at gauging stations

The hydrological Section of MWEM is carrying out the discharge measurement at each stream gauging station to determine and modify the rating curves periodically. The Study Team performed the cross sectional survey at seven (7) stream gauging stations. Based on these H-Q rating curves and cross sectional survey results, the full bank flow capacity at each gauging station was estimated as shown in the following table;

Station. No.	Name of Station	River	Water Depth (m)	Bankful Discharge (m^3/scc)
- Cross sectional survey and discharge measurement results				
1H8	Morogoro Road Bridge	Ruvu	4.5	50.0
Mafisi	new gauging station	Ruvu	4.0	40 - 60
1H3A	Kidunda	Ruvu	5.0	150 - 200
1H5	Kibungo	Ruvu	8.0	1,000
1HA1	Utari Bridge	Ngerengere	7.5	50 - 70
1HB2	Mgeta	Mgeta	3.5	150
Dutumi	New gauging station	Mgeta	4.5	100
- Discharge measurement results				
1H10	Mikula	Ruvu	> 8.0	>600
1HB1	Kisaki	Mgeta		

3 FLOOD SURVEY

3.1 Purposes, Survey Area and Questionnaire

In order to confirm location of flooding, flooding patterns and scale of flood damages, the flood damage survey was executed. Based on the topographic map at a scale of 1 to 50,000, the survey area was selected in places where there seemed to be a possibility of flooding along the rivers and where people lived. The survey areas were selected mainly in the lower Ruvu floodplain. The questionnaire sheet for the flood survey was prepared by the Study Team to interview to the local inhabitants. The questionnaire consists of the record of previous floods, duration of inundation, damages of floods especially to agricultural products and households. The locations of the flood survey are shown in Fig. H.6.

3.2 Flood Prone Area

3.2.1 Lower Ruvu floodplain

As shown in Table H.4 and Fig. H.7, it is clear that the width of the floodplain is 6 km just upstream of the estuary and then it is gradually narrowed to 1.7 km at Mafisi. Thereafter, it is widened at the confluences with the tributaries such as the Vianzi, Usigwa, Mkombezi, Mbiki, Misua and Dutumi on the left bank side and the Ngerengere and Dundanguru (Kitomondo) on the right bank side.

The river course between the estuary and Mafisi is about 84 km, but the meandering low water channel in this area has a length of 156 km. Thus, the low water channel meanders in a range of 600 m to 1,500 m width. In the lower reach below the NUWA's Lower Ruvu Intake, several times of change might take place in the river course, and many old river courses created oxbow lakes. The bottlenecks of the Ruvu River were identified at the following sections;

i) Railway bridge with 7 bridges and 5 culverts,
ii) Morogoro Road Bridge with 1 bridge and 10 culverts, and
iii) Kivukoni ferry and road connecting Bagamoyo and Msata with 9 bridges.

3.2.2 Life of inhabitant in the flood prone area

People living along the Ruvu and other rivers know how to reduce the flood damages through their previous experience as mentioned below:

- houses are built in high or elevated land
- cultivation areas in the flood prone area are given less input before the rainy season.
- in the cultivation areas only the working shelters are built.

During the rainy season from March to May, people plant paddy at their own risk. If a big flood submerging the growing paddy takes place, they get no gains. If the flood does not exceed the top of paddy stem, on the other hand, they can gain more yield than that in the year with no flood. Even if all the planted paddy is damaged, after lowering of the inundation peasants start seeding maize and can get more yield than that in the year with no flood.

According to the interview to the local inhabitants, the Bagamoyo Irrigation Development Project (BIDP) farm was submerged to a depth of about 1 m due to the flood in April/May 1993. Therefore the planted paddy in March/April was completely damaged, but after the flood passed away they tried the second cultivation. Consequently, they could harvest a maximum yield of 8 ton/ha, which is around 50 % higher than the normal yield in September 1993. The similar practice was observed in peasants who were cultivating the floodplain where they could produce higher yield of maize or vegetables through cultivation after the flood in April/May.

3.2.3 Flood course survey

It is found out that through the field investigation that there is no significant sand or silt sedimentation in the Ruvu floodplain. As shown in the topographic maps at a scale of 1 to 50,000, there are many ponds for storing the flood water in the floodplain, some of which are disconnected with the Ruvu after the peak rainy season. They are mainly located along the tributaries in the floodplain such as the Msmbiji and Dutumi Rivers.

The Msumbiji River is conveying water from the Mbiki and Mkombezi, pining to the Ruvu River at a location of 2.5 km downstream of the NUWA's Lower Ruvu intake. During the flood it functions as a part of Ruvu River channel or high water channel. The Msumbiji River channel keeps the water which is poured by the flood in the Ruvu River and receiving the ground water coming from the Mbiki and Mkombezi through the hills of Challinze. Its streamflow was roughly estimated at 20 lit./sec in the vicinity of Migude in October 1993. But the upper end of the present Msumbiji near Kitonga has no flow and no channel connected with the Ruvu is seen in the topographic maps at a scale of 1 to 50,000.

The electrical conductivity (EC) of the Msumbiji is as high as 1,500 to 2,000 μS/cm as compared with that of the Ruvu River near Kitonga which shows a EC of 250 μS/cm. There is

one pumping station to supply water to the refugee camp of UNHCR in Kitonga. This means that the water source of the present flow in the Msumbiji dose not receive water from the Ruvu and that the Msumbiji functions as a part of channel of the Ruvu during the flood.

The Lake Wongomori exsists on the Dutumi River at the toe of Kwala hill. The Dutumi River channel was disconnected with Ruvu during the low water stage and the stored water shows EC values similar to that of the Ruvu. It is pumped to Kwala Town for domestic water supply under MWEM.

3.2.4 Flood marks

The flood water level of the April/May 1993 flood and the road surface elevation at the aforesaid three bottleneck sections were surveyed by the Study Team during the Phase 1 Field Work as follows;

Cross Section No.	Name of Location	Flood Mark (El. m)	Lowest Elevation of Bridge (El. m)	Lowest Eleation of Road Surface (El. m)
2B	Bagamoyo/ Msata Road	2.50	4.0	2.39 (at ferry site) 3.28
7B	Morogoro Road	18.85 (upstream)	20.50 (at Ruvu) 19.86 (at culvert)	19.68
10B	Railway	27.75 Bridge	28.75	28.52

3.2.5 Inundation area in April 1993 Flood

A big flood occured in April 1993 during the period when the Study Team was in Tanzania. According to the Study Team's field inspection, the inundation area of the flood showed the same tendency as the other previous floods in terms of the flooding area. The maximum water level reached to 1 m below the Morogoro Road Bridge at 1H8, and 0.8 m below the floor of intake pumping station at the NUWA's Lower Ruvu intake site, which was about 1.5 m below the water level of the 1979 Flood. The paddy field of Bagamoyo Irrigation Development Project was submerged by 1 m and also the ferry service at Kikongoni was suspended.

3.3 Flood Damage and Benefit

3.3.1 Identified flood damage and benefit

According to the flood survey, the flood damages in the Ruvu River basin are categorized as follows ;

1) partial or perfect damage to planned paddy, which is seeded for the period from January to March,
2) damage to field shelter for the field work of peasants, and
3) indirect damage such as increase of prices of goods coming from outside village, less opportunity to communicate with other villages/towns.

On the other hand, flood benefits were also observed in the Study Area. They are increase of production yield of maize which are planted after damaged paddy cultivation, increase of prices of charcoal and fruits if they can be transported during the flood. The flood supply the nutrition for maintaining the land productivity of inundation area so that less fertilizer is used for cultivation.

These flood damages and benefits are mostly of agricultural costs, and other factors are relatively small. Therefore their estimation was based on the production unit costs or prices which were estimated by the Ministry of Agriculture in the "Basic Data Agriculture and Livestock Sector 1986/87- 1991/92".

3.3.2 Agricultural flood damage and benefit

According to the aforesaid basic data, unit costs of paddy cultivation by typical small holders at lowland in the Coast Region are as follows;

Seed	760 Sh./ha
Tools	427 Sh./ha
Labor input	
Land preparation	50 man-day/ha
Planting	15 man-day/ha
Weeding	60 man-day/ha

Based on the field interview, the maximum cost for construction of shelter for the field works is estimated at Sh. 5,000 and damage of household per family costs Sh. 10,000.

The benefit to be accrued from increase of production is estimated at the farm gate unit price of maize of 13.00 Sh./kg in official price and 16 Sh/kg in open market price in case of the medium technology and medium area.

The results of flood survey are shown in Volume IV: Data Book.

4. INUNDATION ANALYSIS

4.1 Methodology

The inundation analysis was made to confirm the present situation of flooding and to estimate the design water levels required for planning the flood control works, such as digging low water channel, construction of flood dike.

There are many methods for inundation analysis, which are mainly classified into the following three methods;

- Non-uniform flow analysis using a constant flood discharge
- Unsteady flow analysis using the changing discharge time by time, which can represent the actual flooding situation.
- Hydraulic model test by constant discharge or typical flooding pattern.

Among these methods, simplified non-uniform method is adopted in this Study, since the Study is at a level of the master plan and the Study Area has not been much developed or not densely inhabited in the floodplain.

In order to confirm the flow capacity of existing low water channel, the spring tide level is used as the starting sea water level is used in order to find out the bankfull discharge for all the river cross sections.

The inundation analysis of high runoff is made on the peak discharges of previous major floods and peak discharges of 5, 10, 20, 50 and 100-year probable discharges at the gauging station 1H8. The coefficient of roughness in low and high water channels are decided based on the previous flood marks.

4.2 Topographic Maps and Cross Sectional Survey

The topographic maps at a scale of 1 to 50,000, prepared by the Survey of Tanzania for the period from 1954 to 1981 cover the whole Study Area. In addition, the cross sectional survey along lower reach of the Ruvu River was executed by the Study Team in 1993. The Study Team performed the topographic survey for the Study including cross sectional survey 1) along the lower reach of Ruvu River between the river mouth and Mafisi, 2) at the prospective five dam sites, and 3) at seven stream gauging stations including the new stations. The cross sectional survey along the Ruvu River was carried out to clarify the innundation area of lower reach of the Ruvu River which has the high potential of irrigation development. These cross sectional survey results were used for the analysis of flooding in the lower Ruvu as described below.

According to these maps and survey results, the flood prone areas along the Ruvu, Ngerengere and Mgeta Rivers are clearly identified as swamp area where a few villages are plotted on the maps. These are shown in Fig. H.10 and they functions as a retarding basin for the flood.

In the lower Ruvu where the river cross sectional survey was performed by the Study Team, the flood prone areas spread along the river with 5 km wide on average in the alluvial plain. The flood prone areas is little developed and they are used mainly by small-scale peasants as cultivation field where they seed rice and maize during the wet and dry seasons, respectively.

4.3 Tide Effect

4.3.1 General

The water level and discharge in the lower Ruvu, especially near its river mouth, are affected by the movement of sea water level. Sometimes the flow direction of the river changes because of the tide level at the lowermost reach. Regarding the inundation analysis for the tide-affected reaches, the tide level is an important factor for determination of the flood water levels. It is worked out applying the National Land Survey Datum, which is the mean sea water level at Tanga, located about 150 km north of the Ruvu River mouth.

4.3.2 Tide level observation

In order to define 1) the mean sea water level to compare with the National Land Survey Datum and 2) high water level during the flood for the innundation analysis, the Study Team performed the tide level observation for the period from April 20 to May 20, 1993.

The tide gauge was installed on the pier of Mbegani Fisheries Development Center(MFDC), Ministry of Land, Natural Resources, Tourism and Environment. The MFDC is located 8 km southeast of Bagamoyo town or 15 km from the Ruvu River mouth. The site was selected in consideration of the sustainability of the observation and maintenance of the gauge, even though it is rather far from the river mouth. The observation was assisted by the staff of Nautical Science Department of MFDC. The observation was continued by the Department.

4.3.3 Observation results

The hourly sea water levels by gauge reading are tabulated and plotted in Table H.6 and Fig. H.8, respectively. Referring to the tide tables in 1993, published by the Tanzania Harbor Authority, the high and low tide levels at the observed Mbegani and Dar Es Salaam Port are compared as shown in Fig. H.9.

4.3.4 Tide analysis

(1) Gauge datum and national land survey datum

The National Land Survey datum is applied to the cross sectional survey conducted in the Phase 1 Study. The gauge datum, gauge reading at 0.00 m, was surveyed by the Surveyor of the Study Team connecting one of bench mark set for the river cross sectional survey with the gauge. It is found out that the tide gauge datum is -2.34 m by the National Land Survey Datum. This means that the National Land Survey Datum is equivalent to 2.34 m of the tide gauge datum.

(2) Mean sea water level at Mbegani

Based on the observation record, the mean sea water level during the observation period of April 20 to May 20, 1993 is calculated at 2.41 m by the gauge datum which is equivalent to 0.07 m on the National Land Survey Datum. Other tide levels are shown below;

Sea Water Level	Gauge Datum(m)	NLS Datum(m)
- Spring HWL	4.65	2.31
- Neap HWL	4.32	1.98
- MWL	2.41	0.07
- Neap LWL	0.56	-1.78
- Spring LWL	0.30	-2.14

According to the Chart, the mean high level and low level of spring and neap tides at Bagamoyo, Dar Es Salaam and Zanzibar ports are shown below;

Location	Mean HWL		Mean LWL	
	Spring	Neap	Spring	Neap
Bagamoyo	4.11	2.90	0.34	1.55
Dar Es Salaam	3.20	2.07	0.12	0.98
Zanzibar	3.93	2.74	0.18	1.46

Note : based on chart datum in meter

According to the Tanzania Harbor Authority, the water level in the Tide Table 1993 is based on the Chart Datum and the Chart Datum is 1.83 m below National Land Survey Datum. Then our calculation results show that the mean sea water level at Dar Es Salaam Port is 1.54 m by the Chart Datum. Applying these information and data on the tide level of Dar Es Salaam Port, the observation results are analyzed on its specific tide levels.

(3) HWL of spring tide

As the usual practice for the non-uniform flow analysis, the starting sea water level is selected to be high water level of spring tide. For the preliminary estimation of flow capacity of existing river channel, the sea water level for non-uniform flow analysis is set at 2.31 m.

4.4 Non-uniform Flow Analysis

Based on the cross sectional survey conducted by the Study Team in 1993 and the 5, 10, 20, 50 and 100-year probable floods at the stream gauging station 1H8, discussed in Appendix-C of this Supporting Report, the flood water levels along the lower Ruvu were calculated.

4.4.1 Basic data used

(1) River cross section

The location of cross sectional survey is shown in Fig. H.11, and the longitudinal profile of the lowest river bed elevation of low water channels, as well as the right and left bank high-water channel elevations are shown in Fig. H.7.

(2) Sea water level (starting water level)

The high water level of spring tide of Mbegani (Bagamoyo) was set to be the starting sea water level for the non-uniform flow analysis. Then sea water level was tentatively decided to be 2.31 m.

(3) Coefficient of roughness

Coefficients of roughness of low water channel and high water channel were determined based on the trial and error method referring to the previous flood marks. Then it was derived to be 0.03 and 0.065 for the low water channel and high water channel, respectively.

(4) Flood Discharge

The following probable floods derived through the hydrological analysis were used for the non-uniform flow analysis;

Return Period (Year)	Flood Discharge (m^3/sec) at 1H8 (Morogoro Road Bridge.)	Remarks
5	640	
10	820	Apr./May 1993
20	1,005	Apr. 1979
50	1,260	
100	1,460	

The inflow discharge from the tributaries is not taken into account in the above analysis, because the traveling time of peak discharge is estimated to be completely different from one of the Ruvu mainstream. The 10-year probable flood almost coincides with the April/May 1993 flood. Therefore, computed water levels for the 10-year probable flood were compared with the previous flood marks at the Morogoro Road Bridge, NUWA's Lower Ruvu intake and Kikongoni ferry terminal. It was confirmed that the several assumptions made for the non-uniform analysis such as coefficient of roughness and hydraulic coefficients of the existing bridges or culverts are reasonable.

4.4.2 Results of non-uniform flow analysis

The computed water levels for each magnitude of flood which are worked out through the non-uniform flow analysis are shown in Table H. 6, and plotted in Fig. H.10. The analysis results show that;

- Approach road to the Kivukoni ferry is inundated by the flood of more than 635 m^3/sec.
- Approach road to the Morogoro Road Bridge is overtopped by the flood discharge of more than 1,000 m^3/sec (return period of 20-year), but the Morogoro Road Bridge would not be submerged even by the 100-year probabile flood.
- Railway across the Ruvu River would not be submerged even by the 100-year probabile flood.

Thus, the existing important river-related structures, such as trunk road, railway and water intake facilities, are properly designed in view of the safety against flood.

4.4.3 Flood risk map in the lower Ruvu

The inundation areas in the lower Ruvu were analyzed for the 20-year and 100-year probable floods. It was found that the inundation areas to be created by these magnitudes of floods are not so much different. Based on the innundation analysis, the flood risk map for the 100-year probable flood was prepared based on the computed water levels and surveyed river cross sections as shown in Fig. H.11. From the flood risk map, the total inundation area is calculated to be approximately 264 km^2 in the lower Ruvu.

5 FLOOD CONTROL PLAN FOR IRRIGATION DEVELOPMENT

5.1 Flood Control Plan

At first, the necessity of the flood control was examined. If there is no potential for the development or no possibility of inhabitancy or production activities in the floodplain, it should be left as it is from the environmental aspect.

According to the flood damage survey, less flood damages were confirmed in the Ruvu River basin. Besides, the land fertility is sustained by the transport of sediment of nutrition from upstream area by periodical floods. This effect should not be disregarded.

Considering the present economical activities in the floodplain, the flood control plan is set up forcussing mainly on the protection of the irrigation development areas. In order to realize and ensure the agricultural development in the fertile floodplain of the Ruvu River, the flood control works mainly by the construction of flood dike were planned to be provided. The global river training and flood control plan is not considered taking into account the less flood damage in the Study Area.

5.1.1 Objective area for the flood control works

The main objective area for the flood control is the promising irrigation development areas in the lower Ruvu, which are discussed in Appendix-G of this Supporting Report. The proposed irrigation development areas are located on the right bank downstream of the NUWA's Lower Ruvu intake and on the left bank downstream of the NUWA's Upper Ruvu intake. The irrigation canal will be provided along the toe of the right bank hills where no flood damage was observed previously. Therefore the flood control dike is planned to be provided to protect the paddy field during the rainy season.

5.1.2 Degree of protection

It is recommended that the degree of flood control and scale of protection or flood frequency be determined by the economical comparison among the construction cost and benefits obtained by the different protection levels. Considering that the paddy will be planted during the rainy season in the Study Area, it is desirable to protect the paddy field against the 5-year probable flood from the economical viewpoint. Referring to the previous experiences and the design standards/manuals mentioned below, the flood frequencies of 5 and 100-year are adopted for the degree of flood control for irrigation development facilities and water supply intake facilities, respectively.

(1) Design flood for water supply facilities
According to "Water Supply Design Manual" of MLWHUD, Tanzania (1986), the design criteria of the design flood for water supply facilities are as follows;

	Structures	Return Period of Flood
1	Dam, (storage capacity exceeding 60 million m^3)	Possible Maximum Flood or flood of 100-year return period
2	Weir, barrages and small dam (Height<15m, storage capacity <60 million m^3)	flood of 100-year return period
3	Small weir and Minor dam (Height<10m)	flood of 50 to 100-year return period

(2) Design flood for river crossing structures

According to the information, the Ministry of Works of Tanzania has not yet prepared the design manual, but when they construct the river crossing structures, such as bridge, culverts, the flood corresponding to the maximum high water level obtained through the observation of flood marks or hearing to local people, is used for the design of these structures.

(3) Design flood in Japan

The "Manual for River Works" in Japan, recommends the degree of the design flood to be adopted for the flood control purpose, which are categorized based on the social and economic importance of the project area, as show below:

	Category	Design Flood
1	Class A	Return period of more than 200-year
2	Class B	Return period of 100 to 200-year
3	Class C	Return Period of 50 to 100-year
4	Class D	Return period of 10 to 50-year
5	Class E	Return period of less than 10-year

In general, the degree of importance of rivers is ranked as follows:

- In the main section of Class 1 rivers, Class A and Class B are adopted.
- In other sections of Class 1 rivers and Class 2 rivers, Class C is adopted in urban rivers.
- Class D and Class E are in general adopted for the rivers depending upon their importance.

5.1.3 Design flood adopted for the Study

According to the preliminary plan of Kidunda Dam, the dam can have a function of flood peak cut with surcharge volume of reservoir. Based on tthe optimized reservoir scaled, the 5 and 100-year probable floods for the irrigation development areas were estimated by the storage function model. Their results are shown in Fig. H.12, and the design discharges were derived as follows:

Protection Objectives	Return Period (Year)	Max. Spill-out Discharge at Kidunda Dam (m^3/sec)	Peak discharge at 1H8 (m^3/sec)	Design Discharge (m^3/sec)
Irrigation Facilities	5	200	350	360
Water Supply Intakes	100	590	885	910

5.2 Planning of Flood Control Facilities

5.2.1 General

Major flood control facilities for the irrigation development project are flood control dikes and drainage outlets, while those for the domestic water supply are intake weirs.

5.2.2 Flood dike

There are many methods of flood control, of which the best method needs to be decided in consideration of the location and scale of development and importance of structures. The possible flood control methods are as follows;

a) Enclose the project area by flood dike to be constructed along the river
b) Enlargement of flow capacity of low water channel by excavating the river bottom or widening of the river
c) Divert the excess water to drain to the sea through newly constructed floodway.

Usually in the flood mitigation projects, these methods may be combined based on the degree of protection. In this study, the irrigable area is limited as compared with the potential land for irrigation development because of water availability. The method a) using earth-fill dike is adopted in order to protect the irrigation development areas from flood.

5.2.3 Planning drainage outlets

As well as enclosing the irrigation development area by the flood control dike, the internal drainage is very important for miligating flood damage.

The large-scale tributaries lying inside the protected area are planned to be confined by the back dike connected with the main dike along the Ruvu so that upstream flood water of tributary will be drained to the Ruvu River directly. The small-scale tributaries and the internal drainage channel are planned to be drained through the drainage sluices. The drainage facilities consist of the flap gates on the river side and slide gates in the country side, which are to be installed in the concrete box culverts underneath the flood dike. Usually, the slide gates are opened and the drainage us controlled by the flap gates. When the water level of the Ruvu River is lower than the inside one, water inside will be drained to the Ruvu River. When the water level in the Ruvu River becomes higher than internal water level, the flap gates will be closed to stop the entrance of Ruvu water. The slide gates will be operated manually when the flap gate cannot be operated or operated to intentionally increase the inside water level in the project area.

The design discharge for the drainage canal and tributaries are estimated applying the specific discharges of 3.5 and 5.0 lit/sec/ha, respectively, taking into account design rainfall and duration of on-field storage of excessive water.

5.3 Design High Water Level

5.3.1 Design criteria

Based on the design discharge described in the foregoing Section 5.2 and applying the non-uniform flow analysis method, the water level at the irrigation development areas was estimated.

The coefficient of roughness of flood dike side slope is set at 0.03. The freeboard of flood control dike is taken to be 0.60 to 1.00 meter above the design high water level.

5.3.2 Design water level

Based on the above criteria, the design high water level and flood dike height at each irrigation development area was computed by the non-uniform flow analysis. The results of the computation are summarized as follows;

Name of Project	Average Ground Elevation (m)	Design Discharge 360 m^3/sec		Design Discharge 910 m^3/sec	
		HWL (EL. m)	Dike Height (m)	HWL (EL. m)	Dike Height (m)
Bagamoyo Irrigation Dev.	2.70	3.30	1.60	4.70	2.00
MakurungeIrrigation	2.50	3.00	1.50	3.60	2.10
Low Lift Pump Irrigation	13.75	14.05	1.30	14.75	2.00
Ruvu National Youth Irrigation	13.90	14.15	1.25	14.90	2.00

6. PRELIMINARY DESIGN AND COST ESTIMATE OF FLOOD CONTROL WORKS

6.1 Irrigation Projects Requiring Flood Control Works

As discussed in Appendix-G of this Supporting Report, the following irrigation projects situated downstream of the Kidunda dam site are expected to be developed utilizing the dry season water to be exploited through construction of the selected dam projects, namely Kidunda dam in the Development Scenario-1, and Mgeta dam/Ngerengere dam in the Development Scenario-2, which are referred to in Appendix-I of this Supporting Report:

Nominated Irrigation Projects in Association with Dam Development

No.	Development Scenario-1 (Kidunda Dam)	Development Scenario-2 (Mgeta Dam/Ngerengere Dam)
1	Bagamoyo Irrigation Development Project	Bagamoyo Irrigation Development Project
2	Low-lift Pump Irrigation Project	
3	Ruvu National Youth Irrigation Project	
4	Makurunge Irrigation Project	
5	Kidunda Irrigation Project	

With regard to the above irrigation projects, the main features inclusive of the development scale are detailed in Appendix-G of this Supporting Report. All irrigation projects nominated above are located in the flood prone area along the Ruvu River. Therefore, some range of the flood control works are indispensable for these irrigation projects.

As seen in the above table, the Development Scenario-1 involves the development of the five irrigation projects, while the Bagamoyo Irrigation Development Project only is nominated in case of the Development Scenario-2. Besides, the proposed irrigation areas of the Bagamoyo Irrigation Development Project in case of the Development Scenario-1 and -2 are not so much different each other (about 1,000 ha in the both Development Scenarios) as described in Appendix-G of this Supporting Report. Hence, the preliminary design and cost estimate were made for the flood control works required for the irrigation projects associated with the Development Scenario-1 (Kidunda dam project), and the construction cost of the flood control works for the Bagamoyo Irrigation Development Project in the Development Scenario-2 was approximated with reference to that in the Development Scenario-1.

6.2 Flood Control Plan for the Proposed Irrigation Project

6.2.1 Flood control dikes

The flood dike is aligned along the low water channel being set back from the meandering channel, and the end of the dike is planned to be connected to the hills. In order to ensure the stability of the embankment, the set-back distance is taken at 10 m in the minimum.

The dike is designed to have the side slopes of 1:2 taking into account the safety against the slope falure. It is assumed that the ground surface of 50 m in thickness is stripped at the foundation of dike. The embankment materials will be transported from the hilly areas to get the earth materials with enough imperviousness. The slope surfaces are to be protected by sodding. The bank crest is taken at a width of 4 m to be used as an inspection road.

(1) Bagamoyo irrigation development project
- A total of about 13.5 km long dike with an average height of 1.60 m is planned to be constructed.

(2) Low lift pump irrigation project
- A total of about 11.5 km long polder dike with an average height of 1.30 m which is divided by the Mkombeji River, is planned to be constructed.

(3) Makurunge irrigation project
- A total of about 3.5 km long polder dike with an average height of 1.50 m is planned to be constructed.

(4) Ruvu national youth irrigation project
- The existing polder dike is planned to be heightened and/or strengthen for a total length of about 6 km. The average height of the new dike is designed to be 1.25 m.

6.2.2 Drainage sluices

The drainage sluices are designed to be of double section box culverts controlled by the flap gate and slide gate at both ends. The dimensions of drainage sluices were determined to allow the simple and easier operation and maintenance. The standard design of drainage sluices is shown in Fig. H.13.

The requirement of drainage sluices for each irrigation project is described as below;

(1) Bagamoyo irrigation development project
There are two tributaries in the area. Each of these has a small catchment area of less than 20 km^2 and the river slope is very gentle. The swampy area lies at the cental part of the river courses. The river water of these tributaries is planned to be discharged to the Ruvu River collecting the water in secondary drains of the irrigation project, located upstream of the Bagamoyo/Makurunge Road. The drainage structures will be installed at the lowermost end of main drainage channel, totaling 14 sites.

(2) Low lift pump irrigation project
The Mkombeji, the main tributary in the project area, will be discharged along the channel confined by the back dikes. Therefore one set of drainage sluice for internal drainage is planned to be installed in each of two polder dikes.

(3) Makurunge irrigation project
There is no major stream in the project area. A set of drainage sluice for the internal drainage is planned to be installed on the polder dike.

(4) Ruvu National Youth Irrigation Project
The farm is surrounded by the polder dike between the Ruvu and Hizi Rivers. Besides, the drainage outlets are installed but they are not functioning properly. Therefore, reconstruction of the existing drainage outlet as well as new provision of one unit of drainage sluice are proposed.

6.3 Quantity of Flood Control Work for Irrigation Project

Work quantity of flood control works for irrigation development project is calculated for major work items such as earthwork, concrete works and gates. Work quantities of structures are calculated applying the standard design of various dikes and drainage sluices for each irrigation development project.

The quantities of the flood control work are summarized in Table H.7 together with scales of the proposed structures. The Table also shows the work quantities for other irrigation projects than four ones mentioned above, which are taken up as the prospective irrigation projects in this Study.

6.4 Implementation Plan of Flood Control Works

The implementation plans for the flood control works was set up as a part of each of the irrigation development projects as shown in Fig. H.14.

6.5 Cost Estimate

The cost estimate of the flood control works required for the new irrigation projects was made applying the procedures and assumptions explained in Appendix-K of this Supporting Report. It is assumed that the river protection works are to be undertaken by the local contractors. The total construction cost of the flood control works was estimated by the irrigation project as summarized below and detailed in Tables H.9 to H.13;

Total Construction Cost of Flood Control Work for Irrigation Project in the Development Scenario-1

No.	Name of Irrigation Project	Total Present-day Construction Cost (Thousand US$)
1	Bagamoyo Irrigation Development	5,024
2	Low-lift Pump Irrigation	2,822
3	Ruvu National Youth Irrigation	1,041
4	Makurunge Irrigation	1,139
5	Kidunda Irrigation	6,532

The annual disbursement schedule for construction cost of the flood control works was set up by the irrigation project in accordance with the aforesaid implementation schedule as shown in Table H.14.