Table 5.1 PRESENT LAND USE IN PROJECT AREA

Land Use Category or Vegetation	Topography and Drainage Condition	Area (ha)	Proportional Extent (%)
I. Forest		1,050	43.8
(1) Common forest : Partly utilized as logging	Almost flat, imperfect to moderately well drained, partly surface saturated with water in the rainy season	240	10.0
(2) Swampy forest : Partly utilized as getting raphia branches	Almost flat, poor to imperfect drainage, surface inundated through the year	810	33.8
II. Grassland		1,100	45.8
(1) Common grassland : Partly utilized as pasturing of cattle	Flat to gently sloping, moderate to well drainage,	360	15.0
(2) Swampy grassland :	Almost flat, poor drainage, surface submerged through the year	740	30.8
III. Rice field	Reclaimed rice cultivation	10	0.4
IV. Upland Field		240	10.0
(1) Year round crop : food crops or vegetables in both of rainy and dry season	Gently sloping, moderately to well drainage	170	7.1
(2) Dry season crop only :	Almost flat to gently sloping, moderate to well drainage, partly inundated or overwet in the rainy season	70	2.9
Total		2,400	100

Table 5.2(1/14) PLANTED AREA, YIELD AND PRODUCTION OF CROPS IN NOUN DIVISION

Sub-division			Crop Year							
			1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
(1) MAIZE										
Foumban	Production	(ton)	50,300	49,700	57,100	64,800	55,100	59,200	57,600	56,900
	Area	(ha)	43,500	43,600	46,200	49,400	47,600	48,000	48,000	48,000
	Yield	(t/ha)	1.2	1.1	1.2	1.3	1.2	1.2	1.2	1.2
Foumbot	Production	(ton)	65,200	64,400	74,100	84,000	71,400	76,700	73,300	73,800
	Area	(ha)	33,500	33,600	35,600	38,100	36,700	37,000	37,500	37,000
	Yield	(t/ha)	1.9	1.9	2.1	2.2	1.9	2.1	2.0	2.0
Massangam	Production	(ton)	37,300	36,800	42,300	48,000	40,800	43,800	41,900	42,200
	Area	(ha)	24,800	24,900	26,400	28,200	27,200	27,400	27,300	27,400
	Yield	(t/ha)	1.5	1.5	1.6	1.7	1.5	1.6	1.5	1.5
Magba	Production	(ton)	24,200	23,900	27,500	31,200	26,500	28,500	26,200	27,400
	Area	(ha)	16,100	16,200	17,200	18,400	17,700	17,800	17,100	17,800
	Yield	(t/ha)	1.5	1.5	1.6	1.6	1.5	1.6	1.5	1.5
Malantouen	Production	(ton)	9,300	9,200	10,600	12,000	10,200	11,000	10,500	10,500
	Area	(ha)	6,200	6,200	6,600	7,100	6,800	6,900	6,800	6,900
	Yield	(t/ha)	1.5	1.5	1.6	1.7	1.5	1.6	1.5	1.5
Noun Total	Production	(ton)	186,300	184,000	211,600	240,000	240,000	219,200	209,500	210,800
	Area	(ha)	124,100	124,500	132,000	142,200	136,000	137,100	137,100	164,100
	Yield	(t/ha)	1.5	1.4	1.6	1.7	1.5	1.6	1.5	1.3
(2) RICE										
Foumban	Production	(ton)	140	250	430	570	40	40	50	50
	Area	(ha)	190	150	240	260	20	20	30	30
	Yield	(t/ha)	0.7	1.7	1.8	2.2	2.0	2.0	1.7	1.7
Foumbot	Production	(ton)	100	150	480	230	30	30	20	20
	Area	(ha)	130	90	270	100	20	20	10	10
	Yield	(t/ha)	0.8	1.7	1.8	2.1	1.5	1.5	2.0	2.0
Massangam	Production	(ton)	10	10	20	40	5	3	6	10
	Area	(ha)	10	6	10	20	3	2	3	5
	Yield	(t/ha)	1.0	1.7	2.0	2.0	1.7	1.5	2.0	2.0
Magba	Production	(ton)	10	20	80	80	-	-	-	-
	Area	(ha)	10	10	40	40	-	-	-	-
	Yield	(t/ha)	1.0	2.0	2.0	2.0	-	-	-	-
Malantouen	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Noun Total	Production	(ton)	260	430	1,010	920	75	73	76	80
	Area	(ha)	340	256	560	430	43	42	43	45
	Yield	(t/ha)	0.7	1.6	1.8	2.1	1.7	1.7	1.7	1.7

Table 5.2(2/14) PLANTED AREA, YIELD AND PRODUCTION OF CROSS IN NOUN DIVISION

Sub-division			Crop Year 1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
(3) YAM										
Foumban	Production	(ton)	11,800	11,800	13,200	13,200	9,700	9,000	9,000	9,100
	Area	(ha)	1,000	1,000	4,700	4,800	3,900	3,900	3,900	3,900
	Yield	(t/ha)	11.8	11.8	2.8	2.8	2.5	2.5	2.3	2.3
Foumbot	Production	(ton)	43,300	43,400	48,300	48,500	35,700	33,000	33,200	33,300
	Area	(ha)	3,600	3,700	17,300	17,700	14,200	14,300	14,300	14,300
	Yield	(t/ha)	12.0	11.7	2.8	2.7	2.5	2.3	2.3	2.3
Massangam	Production	(ton)	9,400	9,500	10,600	10,600	7,800	7,200	7,200	7,300
	Area	(ha)	800	800	3,800	3,900	3,100	3,100	3,100	3,100
	Yield	(t/ha)	11.8	11.9	2.8	2.7	2.5	2.3	2.3	2.4
Magba	Production	(ton)	7,900	7,900	8,800	8,800	6,500	6,000	6,000	6,100
	Area	(ha)	700	700	3,200	3,200	2,600	2,600	2,600	2,600
	Yield	(t/ha)	11.3	11.3	2.8	2.8	2.5	2.3	2.3	2.3
Malantouen	Production	(ton)	6,300	6,300	7,000	7,100	5,200	4,800	4,800	4,800
	Area	(ha)	500	500	2,500	2,600	2,100	2,100	2,100	2,100
	Yield	(t/ha)	12.6	12.6	2.8	2.7	2.5	2.3	2.3	2.3
Noun Total	Production	(ton)	78,700	78,900	87,900	88,200	64,900	60,000	60,200	60,600
	Area	(ha)	6,600	6,700	31,500	32,200	25,900	26,000	26,000	26,600
	Yield	(t/ha)	11.9	11.7	2.8	2.7	2.5	2.3	2.3	2.3
(4) COCOYAM										
Foumban	Production	(ton)	3,400	3,400	3,700	1,300	1,100	1,100	1,100	1,100
	Area	(ha)	300	300	1,800	1,800	400	400	400	400
	Yield	(t/ha)	11.3	11.3	2.1	0.7	2.8	2.8	2.8	2.8
Foumbot	production	(ton)	15,200	15,500	16,800	6,000	4,800	4,700	4,800	5,000
	Area	(ha)	1,300	1,400	8,100	8,300	1,700	1,600	1,600	1,700
	Yield	(t/ha)	11.7	11.1	2.1	0.7	2.8	2.9	3.0	2.9
Massangam	Production	(ton)	4,000	4,100	4,500	1,600	1,300	1,300	1,300	1,300
	Area	(ha)	400	400	2,200	2,200	500	400	400	400
	Yield	(t/ha)	10.0	10.3	2.0	0.7	2.6	3.2	3.2	3.2
Magba	Production	(ton)	10,100	10,300	11,200	4,000	3,200	3,200	3,200	3,300
	Area	(ha)	900	900	5,400	5,500	1,100	1,100	1,100	1,100
	Yield	(t/ha)	11.2	11.4	2.0	0.7	2.9	2.9	2.9	3.0
Malantouen	Production	(ton)	1,000	1,000	1,100	400	300	300	300	300
	Area	(ha)	100	100	500	600	100	100	100	100
	Yield	(t/ha)	10.0	10.0	2.2	0.6	3.0	3.0	3.0	3.0
Noun Total	Production	(ton)	33,700	34,300	73,500	13,300	10,700	10,600	10,700	11,000
	Area	(ha)	3,000	3,100	18,000	18,400	3,800	3,600	3,600	3,700
	Yield	(t/ha)	11.2	11.06	4.08		2.8	2.9	2.97	2.97

Table 5.2(3/14) PLANTED AREA, YIELD AND PRODUCTION OF CROPS IN NOUN DIVISION

Sub-division			Crop Year							
			1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
(5) TARO										
Foumban	Production	(ton)	800	90	100	100	90	90	90	90
	Area	(ha)	80	80	200	200	20	20	20	30
	Yield	(t/ha)	10.0	1.1	0.5	0.5	4.5	4.5	4.5	3.0
Foumbot	Production	(ton)	4,000	400	500	500	400	400	100	400
	Area	(ha)	400	400	900	900	100	100	400	100
	Yield	(t/ha)	10.0	1.0	0.5	0.5	4.0	4.0	0.2	4.0
Massangam	Production	(ton)	700	70	90	90	80	80	80	80
	Area	(ha)	70	70	170	170	20	20	20	30
	Yield	(t/ha)	10.0	1.0	0.5	0.5	4.0	4.0	0.2	4.0
Magba	Production	(ton)	6,100	400	500	500	500	500	500	500
	Area	(ha)	400	400	1,000	1,000	100	100	100	200
	Yield	(t/ha)	15.2	1.0	0.5	0.5	5.0	5.0	5.0	2.5
Malantouen	Production	(ton)	70	50	60	60	60	60	60	60
	Area	(ha)	50	50	120	120	10	10	10	20
	Yield	(t/ha)	1.4	1.0	0.5	0.5	6.0	6.0	6.0	3.1
Noun Total	Production	(ton)	11,670	1,010	1,850	1,850	1,130	1,130	1,020	1,130
	Area	(ha)	1,480	1,000	2,390	2,390	250	250	550	380
	Yield	(t/ha)	7.9	1.01	0.8	4.5	4.5	4.5	1.85	2.95
(6) SWEET POTATO										
Foumban	Production	(ton)	14,100	12,500	11,600	11,100	8,700	8,600	8,800	8,900
	Area	(ha)	1,200	1,100	4,500	4,700	3,600	3,400	3,400	3,500
	Yield	(t/ha)	11.75		2.6	2.4	2.4	2.5	2.6	2.5
Foumbot	Production	(ton)	12,100	10,700	10,000	9,500	7,400	7,400	7,500	7,600
	Area	(ha)	1,100	900	3,900	4,100	3,100	2,900	2,900	3,000
	Yield	(t/ha)	11.0	11.4	2.50	2.3	2.4	2.55	2.6	2.5
Massangam	Production	(ton)	4,000	3,600	3,300	3,200	2,500	2,500	2,500	2,500
	Area	(ha)	400	300	1,300	1,400	1,000	1,000	1,000	1,000
	Yield	(t/ha)	10.0	12.0	2.5	2.3	2.5	2.5	2.5	2.5
Magba	Production	(ton)	4,000	3,600	3,300	3,200	2,500	2,500	2,500	2,500
	Area	(ha)	400	300	13,000	1,400	1,000	1,000	1,000	1,000
	Yield	(t/ha)	10.0	12.0	2.5	2.3	2.5	2.5	2.5	2.5
Malantouen	Production	(ton)	6,000	50,300	5,000	4,750	3,700	3,700	3,750	3,800
	Area	(ha)	500	5,000	1,900	2,000	1,500	1,400	1,500	1,500
	Yield	(t/ha)	12.0	100.6	2.6	2.4	2.45	2.6	2.5	2.5
Noun Total	Production	(ton)	40,200	80,700	33,200	58,750	24,800	24,700	25,050	25,300
	Area	(ha)	3,600	3,100	12,900	13,600	10,200	9,700	9,800	10,000
	Yield	(t/ha)	11.1	26.0	2.6	4.3	2.4	2.5	2.55	2.5

Table 5.2(4/14) PALNTED AREA, YIELD AND PRODUCTION OF CROPS IN NOUN DIVISION

Sub-division			Crop Year							
			1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
(7) CASSAVA										
Foumban	Production	(ton)	15,000	15,000	16,000	15,800	14,300	14,000	14,200	14,500
	Area	(ha)	1,000	1,000	3,700	4,000	4,900	5,000	5,000	5,000
	Yield	(t/ha)	15.0	15.0	4.3	3.9	2.9	2.8	2.8	2.9
Foumbot	Production	(ton)	18,700	18,800	19,700	19,700	17,900	17,500	17,800	18,200
	Area	(ha)	1,200	1,300	4,600	5,000	6,200	6,200	6,200	6,300
	Yield	(t/ha)	15.5	14.4	4.2	3.9	2.8	2.8	2.8	2.8
Massangam	Production	(ton)	13,500	13,500	14,200	14,200	12,900	12,600	12,800	13,100
	Area	(ha)	900	900	3,300	3,600	4,400	4,500	4,500	4,500
	Yield	(t/ha)	15.0	15.0	4.3	3.9	2.9	2.8	2.8	2.9
Magba	Production	(ton)	17,200	17,300	18,100	18,200	16,400	16,100	16,300	16,700
	Area	(ha)	1,100	1,200	4,400	4,600	5,700	5,700	5,700	5,800
	Yield	(t/ha)	15.6	14.4	4.2	3.9	2.8	2.8	2.8	2.8
Malantouen	Production	(ton)	10,500	10,500	11,000	11,100	10,000	9,8-0	9,900	10,200
	Area	(ha)	700	700	2,600	2,800	3,5-0	3,500	3,5-0	3,500
	Yield	(t/ha)	15.0	15.0	4.2	3.9	2.8	2.8	2.8	2.9
Noun Total	Production	(ton)	74,900	75,100	79,000	79,000	71,500	70,000	85,200	72,700
	Area	(ha)	4,900	5,100	18,500	20,000	21,200	24,900	24,900	25,100
	Yield	(t/ha)	15.3	14.7	4.3	3.95	3.4	2.8	2.4	2.9
(8) PLANTAIN										
Foumban	Production	(ton)	22,100	23,200	24,100	24,300	23,800	22,200	22,800	23,500
	Area	(ha)	4,400	4,600	28,000	29,100	30,400	30,400	30,600	30,600
	Yield	(t/ha)	5.0	5.0	0.8	0.8	0.8	0.7	0.7	0.75
Foumbot	Production	(ton)	22,800	23,900	24,900	25,100	24,600	22,900	23,500	24,200
	Area	(ha)	4,600	4,800	28,900	30,000	31,400	31,400	31,500	31,600
	Yield	(t/ha)	4.9	4.9	0.8	0.8	0.8	0.7	0.7	0.75
Massangam	Production	(ton)	13,800	14,500	15,100	15,200	14,900	13,900	14,200	14,700
	Area	(ha)	2,800	2,900	17,500	18,200	19,000	19,000	19,100	19,000
	Yield	(t/ha)	4.9	5.0	0.8	0.8	0.8	0.7	0.7	0.75
Magba	Production	(ton)	6,900	700	7,540	7,600	7,500	7,000	7,100	7,300
	Area	(ha)	1,400	1,500	8,750	9,100	9,500	9,500	9,600	9,600
	Yield	(t/ha)	4.9	0.4	0.8	0.8	0.8	0.7	0.7	0.75
Malantouen	Production	(ton)	3,500	3,600	3,800	3,800	3,700	3,500	3,600	3,700
	Area	(ha)	700	700	4,400	4,600	4,800	4,800	4,800	4,800
	Yield	(t/ha)	5.0	5.1	0.8	0.8	0.8	0.7	0.75	0.8
Non Total	Production	(ton)	69,100	65,900	75,440	76,000	74,500	69,500	71,200	73,400
	Area	(ha)	13,900	14,500	87,550	91,000	95,100	99,900	95,600	95,700
	Yield	(t/ha)	4.95	4.5	0.85	0.8	0.8	0.7	0.7	0.75

Table 5.2(5/14) PLANTED AREA, YIELD AND PRODUCTION OF CROPS IN NOUN DIVISION

Sub-division			Crop Year 1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
(9) BANANA										
Foumban	Production	(ton)	3,300	3,300	3,400	3,400	3,000	2,800	2,800	2,900
	Area	(ha)	600	700	3,500	3,600	3,700	3,700	3,700	3,800
	Yield	(t/ha)	5.5	4.7	0.9	0.9	0.8	0.75	0.75	0.75
Foumbot	Production	(ton)	16,600	16,600	17,100	17,200	15,100	14,000	14,100	14,500
	Area	(ha)	3,300	3,300	17,400	17,900	18,400	18,400	18,400	18,900
	Yield	(t/ha)	5.0	5.0	0.95	0.9	0.8	0.75	0.75	0.75
Massangam	Production	(ton)	5,700	5,700	5,900	5,900	5,200	4,800	4,800	5,000
	Area	(ha)	1,100	1,100	6,000	6,100	6,300	6,300	6,300	6,500
	Yield	(t/ha)	5.1	5.1	0.95	0.95	0.8	0.75	0.75	0.75
Magba	Production	(ton)	19,000	19,000	19,500	19,600	17,300	16,000	16,100	16,600
	Area	(ha)	3,800	3,800	19,900	20,400	21,000	21,000	21,100	21,600
	Yield	(t/ha)	5.0	5.0	0.95	0.95	0.8	0.75	0.75	0.75
Malantouen	Production	(ton)	2,800	2,900	2,900	2,900	2,600	2,400	2,400	2,500
	Area	(ha)	600	600	3,000	3,000	3,200	3,200	3,200	3,200
	Yield	(t/ha)	4.6	4.8	0.95	0.95	0.8	0.75	0.75	0.75
Noun Total	Production	(ton)	47,400	47,500	48,800	49,000	43,200	40,000	40,200	41,500
	Area	(ha)	9,400	9,500	49,800	51,000	52,600	52,600	52,700	54,000
	Yield	(t/ha)	5.0	5.0	0.95	0.95	0.8	0.75	0.75	0.75
(10) GROUNDNUT										
Foumban	Production	(ton)	12,700	12,600	12,900	12,600	8,200	8,200	7,700	7,800
	Area	(ha)	10,600	9,100	12,900	13,000	10,200	10,200	10,200	10,200
	Yield	(t/ha)	1.2	1.4	1.0	0.95	0.8	0.8	0.75	0.75
Foumbot	Production	(ton)	16,900	16,800	17,200	16,700	10,900	10,900	10,400	10,400
	Area	(ha)	14,100	12,100	17,300	17,300	13,600	13,600	13,600	13,600
	Yield	(t/ha)	1.2	1.4	0.95	0.95	0.8	0.8	0.75	0.75
Massangam	Production	(ton)	16,200	16,1-0	16,400	16,000	13,000	10,500	9,900	10,000
	Area	(ha)	13,500	11,600	16,500	16,600	10,400	13,100	13,000	13,100
	Yield	(t/ha)	1.2	1.4	0.95	0.95	1.25	0.8	0.75	0.75
Magba	Production	(ton)	14,100	14,000	14,300	13,900	9,100	9,100	8,600	8,700
	Area	(ha)	11,700	10,100	14,400	14,400	11,300	11,400	11,300	11,400
	Yield	(t/ha)	1.2	1.4	0.95	0.95	0.8	0.8	0.75	0.75
Malantouen	Production	(ton)	10,600	10,600	10,700	10,500	6,800	6,800	6,500	6,500
	Area	(ha)	8,800	7,600	10,800	10,800	8,500	8,500	8,500	8,500
	Yield	(t/ha)	1.2	1.4	0.95	0.95	0.8	0.8	0.75	0.75
Noun Total	Production	(ton)	70,500	70,100	71,500	69,700	64,400	45,500	43,100	43,400
	Area	(ha)	58,700	50,500	71,900	72,100	54,000	56,800	56,600	56,800
	Yield	(t/ha)	1.2	1.4	0.95	0.95	1.2	0.8	0.75	0.75

Table 5.2(6/14) PLANTED AREA, YIELD AND PRODUCTION OF CROPS IN NOUN DIVISION

Sub-division			Crop Year							
			1977/78	1978/79	1979/80	1080/81	1981/82	1982/83	1983/84	1984/85
(11) HARICOT BEAN										
Foumban	Production	(ton)	11,300	11,400	11,300	13,200	11,900	12,000	10,700	10,900
	Area	(ha)	4,500	4,500	11,400	7,400	7,900	8,000	7,600	7,700
	Yield	(t/ha)	2.5	2.5	0.95	1.8	1.5	1.5	1.4	1.4
Foumbot	Production	(ton)	19,700	19,900	19,700	23,100	20,800	20,900	18,700	19,000
	Area	(ha)	7,900	7,900	20,000	13,000	13,900	14,000	13,300	13,500
	Yield	(t/ha)	2.4	2.5	0.95	1.75	1.5	1.5	1.4	1.40
Massangam	Production	(ton)	14,100	14,200	14,100	16,500	14,900	14,900	13,400	13,600
	Area	(ha)	5,600	5,700	14,300	9,300	9,900	10,000	9,500	9,600
	Yield	(t/ha)	2.4	2.5	0.95	1.75	1.5	1.5	1.5	1.5
Magba	Production	(ton)	4,500	4,500	4,500	5,300	4,800	4,800	4,300	4,300
	Area	(ha)	1,800	1,800	4,600	3,000	3,200	3,200	3,000	3,100
	Yield	(t/ha)	2.5	2.5	0.95	1.75	1.5	1.5	1.4	1.4
Malantouen	Production	(ton)	6,800	6,800	6,800	7,900	7,100	7,200	6,400	6,500
	Area	(ha)	2,700	2,700	6,800	4,500	4,800	4,800	4,600	4,600
	Yield	(t/ha)	2.5	2.5	1.0	1.75	1.5	1.5	1.4	1.4
Noun Total	Production	(ton)	56,400	56,800	56,400	66,000	59,500	59,800	53,500	54,300
	Area	(ha)	22,500	22,600	57,100	37,200	39,700	40,000	38,000	38,500
	Yield	(t/ha)	2.5	2.5	0.95	1.8	1.5	1.5	1.4	1.4
(12) CABBAGE										
Foumban	Production	(ton)	130	130	1,300	200	180	190	150	150
	Area	(ha)	170	160	230	250	20	200	180	180
	Yield	(t/ha)	0.75	0.8	5.65	0.8	9.0	0.95	0.8	0.8
Foumbot	Production	(ton)	1,200	1,150	11,545	1,790	1,610	1,680	1,340	1,340
	Area	(ha)	1,500	1,430	2,050	2,240	180	1,800	1,610	1,650
	Yield	(t/ha)	0.8	0.8	5.6	0.8	8.9	0.9	0.8	0.8
Massangam	Production	(ton)	7	7	65	10	9	9	8	8
	Area	(ha)	8	8	12	13	1	10	9	9
	Yield	(t/ha)	0.8	0.8	5.4	0.75	9.0	0.9	0.9	0.9
Magba	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(t/ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Malantouen	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Noun Total	Production	(ton)	1,337	1,287	12,910	2,000	1,799	1,879	1,498	1,498
	Area	(ha)	1,678	1,598	2,292	2,503	201	2,010	1,799	1,839
	Yield	(t/ha)	0.8	0.8	5.6	0.8	8.95	0.9	0.8	0.8

Table 5.2(7/14) PLANTED AREA, YIELD AND PRODUCTION OF CROPS IN NOUN DIVISION

Sub-division			Crop Year							
			1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
(13) ONION										
Foumban	Production	(ton)	0.4	0.5	4.2	5	4.5	4.5	2.5	2
	Area	(ha)	0.5	0.7	6.2	8	7.5	7.5	5	5.05
	Yield	(t/ha)	0.8	0.7	0.7	0.6	0.6	0.6	0.5	0.4
Foumbot	Production	(ton)	3.6	4.2	37.6	44.8	40.3	39.4	22.4	17.9
	Area	(ha)	4.5	6.3	55.5	71.6	67.1	67.1	44.4	45.2
	Yield	(t/ha)	0.8	0.6	0.7	0.6	0.6	0.9	0.5	0.4
Massangam	Production	(ton)	0.02	0.02	0.2	0.25	0.2	0.2	0.1	0.1
	Area	(ha)	0.025	0.035	0.3	0.4	0.4	0.4	0.25	0.25
	Yield	(t/ha)	0.8	0.6	0.6	0.6	0.5	0.5	0.4	0.4
Magba	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Malantouen	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Noun Total	Production	(ton)	4.02	4.72	42.0	50.05	45.0	44.0	25.0	20.0
	Area	(ha)	5,025	7,035	62.0	80.0	75.0	75.0	49.65	20.5
	Yield	(t/ha)	0.8	0.7	0.7	0.6	0.6	0.6	0.5	0.4
(14) LETTUCE										
Foumban	Production	(ton)	130	140	140	260	180	185	190	380
	Area	(ha)	170	180	340	470	370	370	380	200
	Yield	(t/ha)	0.8	0.8	0.4	0.55	0.5	0.5	0.5	1.9
Foumbot	Production	(ton)	1,150	1,200	1,230	2,230	1,570	1,575	1,610	3,230
	Area	(ha)	1,430	1,500	2,860	4,030	3,130	3,130	3,220	1,710
	Yield	(t/ha)	0.8	0.8	0.4	0.55	0.5	0.5	0.5	1.9
Massangam	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Magba	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Malantouen	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Noun Total	Production	(ton)	1,280	1,340	1,370	2,490	1,750	1,760	1,800	3,610
	Area	(ha)	1,600	1,680	3,200	4,500	3,500	3,500	3,600	1,910
	Yield	(t/ha)	0.8	0.8	0.4	0.55	0.5	0.5	0.5	1.9

Table 5.2(8/14) PLANTED AREA, YIELD AND PRODUCTION TO CROPS IN NOUN DIVISION

Sub-division				Crop Year							
				1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
(15)	CARROT										
	Foumban	Production	(ton)	30	30	50	160	180	180	180	250
		Area	(ha)	30	30	135	250	260	260	250	180
		Yield	(t/ha)	1.0	1.0	0.4	0.6	0.7	0.7	0.7	1.4
	Foumbot	Production	(ton)	335	340	530	1,640	1,800	1,800	o,780	2,570
		Area	(ha)	335	340	1,365	2,550	2,600	2,600	2,550	1,860
		Yield	(t/ha)	1.0	1.0	0.4	0.6	0.7	0.7	0.7	1.4
	Massangam	Production	(ton)	-	-	-	-	-	-	-	-
		Area	(ha)	-	-	-	-	-	-	-	-
		Yield	(t/ha)	-	-	-	-	-	-	-	-
	Magba	Production	(ton)	-	-	-	-	-	-	-	-
		Area	(ha)	-	-	-	-	-	-	-	-
		Yield	(t/ha)	-	-	-	-	-	-	-	-
	Malantouen	Production	(ton)	-	-	-	-	-	-	-	-
		Area	(ha)	-	-	-	-	-	-	-	-
		Yield	(t/ha)	-	-	-	-	-	-	-	-
	Noun Total	Production	(ton)	365	370	580	1,800	1,980	1,980	1,960	2,820
		Area	(ha)	365	370	1,500	2,800	2,860	2,860	2,800	2,040
		Yield	(t/ha)	1.0	1.0	0.4	0.6	0.7	0.7	0.7	1.4
(16)	EGGPLANT										
	Foumban	Production	(ton)	140	140	150	220	190	190	195	40
		Area	(ha)	116	117	2,170	500	420	420	420	190
		Yield	(t/ha)	1.2	1.2	0.07	0.4	0.45	0.45	0.45	0.2
	Foumbot	Production	(ton)	525	525	570	825	710	715	730	160
		Area	(ha)	440	440	8,140	1,875	1,575	1,580	1,580	730
		Yield	(t/ha)	1.2	1.2	0.07	0.4	0.45	0.45	0.45	0.2
	Massangam	Production	(ton)	14	14	15	22	19	19	19	5
		Area	(ha)	12	11	220	50	42	42	42	19
		Yield	(t/ha)	1.15	1.3	0.07	0.4	0.45	0.45	0.45	0.25
	Magba	Production	(ton)	10	11	12	17	14	14	15	3
		Area	(ha)	9	9	163	38	32	31	32	15
		Yield	(t/ha)	1.1	1.2	0.07	0.4	0.4	0.45	0.45	0.2
	Malantouen	Production	(ton)	11	11	11	16	14	15	15	3
		Area	(ha)	9	9	163	37	31	32	32	15
		Yield	(t/ha)	1.2	1.2	0.07	0.4	0.45	0.45	0.45	0.2
	Noun Total	Production	(ton)	700	701	758	1,100	947	953	974	211
		Area	(ha)	586	597	10,856	2,500	2,100	2,105	2,106	969
		Yield	(t/ha)	1.2	1.2	0.06	0.4	0.45	0.45	0.45	0.2

Table 5.2(9/14) PLANTED AREA, YIELD AND PRODUCTION TO CROPS IN NOUN DIVISION

Sub-division			Crop Year							
			1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
(17) WATER MELON										
Foumban	Production	(ton)	0.04	0.15	0.2	1	0.45	0.475	0.2	1
	Area	(ha)	0.01	0.05	1.0	1	0.5	0.525	0.4	0.3
	Yield	(t/ha)	4.0	3.0	0.2	1.0	0.9	0.9	0.5	3.3
Foumbot	Production	(ton)	0.8	2.85	4,275	14	8.55	9,025	3.8	10
	Area	(ha)	0.25	0.95	13	14	9.5	9.975	7.6	5.7
	Yield	(t/ha)	3.2	3.0	0.3	1.0	0.9	0.9	0.5	1.75
Massangam	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Magba	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Malantouen	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Noun Total	Production	(ton)	0.8	3.0	4.4	15	9	9.5	4	11
	Area	(ha)	0.25	1.0	14	15	10	10.5	8	6
	Yield	(t/ha)	3.2	3.0	0.3	1.0	0.9	0.9	0.5	1.8
(18) PERSLEY										
Foumban	Production	(ton)	0.25	0.055	1	1	0.625	0.625	1	1
	Area	(ha)	0.25	0.275	4	25	0.675	0.675	1	0.525
	Yield	(t/ha)	1.0	0.2	0.25	0.04	0.9	0.9	1.0	1.9
Foumbot	Production	(ton)	0.95	1,045	11	12	11,875	11,875	9	11
	Area	(ha)	4.75	5,225	76	75	12,825	12,825	11	9,975
	Yield	(t/ha)	0.2	0.2	0.1	0.15	0.9	0.9	0.8	1.1
Massangam	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Magba	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Malantouen	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Noun Total	Production	(ton)	1.2	1.1	12	13	12.5	12.5	10	12
	Area	(ha)	5.0	5.5	80	100	13.5	13.5	12	10.5
	Yield	(t/ha)	0.2	0.2	0.15	0.13	0.9	0.9	0.8	1.1

Table 5.2(10/14) PLANTED AREA, YIELD AND PRODUCTION TO CROPS IN NOUN DIVISION

Sub-division			Crop Year 1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
(19) RADISH										
Foumban	Production	(ton)	1	1	1	1	1	1	1	6
	Area	(ha)	0.4	0.25	6	7	6	5	6	0.85
	Yield	(t/ha)	2.5	4.0	0.15	0.1	0.15	0.2	0.15	0.07
Foumbot	Production	(ton)	36	37	43	59	48	49	41	29
	Area	(ha)	18.1	12.7	274	313	294	300	294	41.65
	Yield	(t/ha)	1.95	2.9	0.15	0.2	0.15	0.15	0.1	0.7
Massangam	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Magba	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Malantouen	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Noun Total	Production	(ton)	37	38	44	60	49	50	42	35
	Area	(ha)	18.5	12.95	280	320	300	305	300	42.5
	Yield	(t/ha)	2.0	2.9	0.15	0.2	0.15	0.15	0.1	0.8
(20) SWEET PEPPER										
Foumban	Production	(ton)	0.75	3	3.075	3.45	2.25	2.55	2.85	24
	Area	(ha)	1.05	1.5	22.5	30	22.5	22.8	23.25	3.075
	Yield	(t/ha)	0.7	2.0	0.1	0.1	0.1	0.1	0.1	7.8
Foumbot	Production	(ton)	4	16	16.4	18.4	12	13.6	15.2	126
	Area	(ha)	5.60	8	120	160	120	121.6	124	16.4
	Yield	(t/ha)	0.7	2	0.1	0.1	0.1	0.1	0.1	7.7
Massangam	Production	(ton)	0.25	1	1.025	1.15	0.75	0.85	0.95	8
	Area	(ha)	0.35	0.5	7.5	10	7.5	7.6	7.75	1,025
	Yield	(t/ha)	0.7	2.0	0.1	0.1	0.1	0.1	0.1	7.8
Magba	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Malantouen	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Noun Total	Production	(ton)	5	20	20.5	23	29.25	17	19	158
	Area	(ha)	7	10	150	200	150	152	155	20.5
	Yield	(t/ha)	0.7	2.0	0.1	0.1	0.2	0.1	0.1	7.7

Table 5.2(11/14) PLANTED AREA, YIELD AND PRODUCTION TO CROPS IN NOUN DIVISION

Sub-division			Crop Year							
			1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
(21) FRESH BEAN (Green)										
Foumban	Production	(ton)	21	23	23	25	26	26	20	68
	Area	(ha)	8	9	65	75	77	77	68	21
	Yield	(t/ha)	2.6	2.55	0.35	0.3	0.3	0.3	0.3	3.2
Foumbot	Production	(ton)	108	127	133	140	144	146	114	387
	Area	(ha)	47	51	365	425	438	438	382	119
	Yield	(t/ha)	2.5	2.5	0.4	0.3	0.3	0.3	0.3	3.25
Massangam	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Magba	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Malantouen	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Noun Total	Production	(ton)	139	150	156	165	170	172	134	455
	Area	(ha)	55	60	430	500	515	515	450	140
	Yield	(t/ha)	2.5	2.5	0.35	0.3	0.3	0.3	0.3	3.25
(22) AFRICAN VEGETABLES										
Foumban	Production	(ton)	6,090	9.75	1,120	2,090	2,420	3,080	3,300	8,470
	Area	(ha)	2,440	2,440	4,840	6,600	7,040	8,140	8,250	3,630
	Yield	(t/ha)	2.5	0.003	0.2	0.3	0.3	0.4	0.4	2.3
Foumbot	Production	(ton)	6,920	11.08	1,270	2,375	2,750	3,500	3,750	9,625
	Area	(ha)	2,770	2,770	5,500	7,500	8,000	9,250	9,375	4,125
	Yield	(t/ha)	2.5	0.4	0.2	0.3	0.3	0.4	0.4	2.3
Massangam	Production	(ton)	4,985	8.0	917	1,710	1,980	2,520	2,700	4,125
	Area	(ha)	1,990	1,990	3,960	5,400	5,760	6,660	6,750	2,970
	Yield	(t/ha)	2.5	0.004	0.2	0.3	0.3	0.4	0.4	2.3
Magba	Production	(ton)	5,540	8.9	1,019	1,900	2,200	2,800	3,000	7,700
	Area	(ha)	2,215	2,216	4,400	6,000	6,400	7,400	7,500	3,300
	Yield	(t/ha)	2.5	0.004	0.2	0.3	0.3	0.4	0.4	2.3
Malantouen	Production	(ton)	4,150	6.6	765	1,425	1,650	2,100	2,250	5,775
	Area	(ha)	1,660	1,660	3,300	4,500	4,800	5,550	5,625	2,475
	Yield	(t/ha)	2.5	0.004	0.2	0.3	0.3	0.4	0.4	2.3
Noun Total	Production	(ton)	27,685	54.08	5,091	9,500	11,000	14,000	15,000	38,500
	Area	(ha)	11,075	11,076	22,000	30,000	32,000	38,000	38,500	16,500
	Yield	(t/ha)	2.5	0.005	0.2	0.3	0.3	0.4	0.4	2.3

Table 5.2(12/14) PLANTED AREA, YIELD AND PRODUCTION TO CROPS IN NOUN DIVISION

Sub-division			Crop Year							
			1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
(23) TURNIP										
Foumban	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Foumbot	Production	(ton)	43	43.2	44	90	65	64	35	100
	Area	(ha)	21.5	26.1	10,200	150	110	115	110	35.5
	Yield	(t/ha)	2.0	1.65	0.004	0.6	0.6	0.55	0.35	2.8
Massangam	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Magba	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Malantouen	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Noun Total	Production	(ton)	43	43.2	44	90	65	64	35	100
	Area	(ha)	21.5	26.1	10,200	150	110	115	100	35.5
	Yield	(t/ha)	2.0	1.65	0.004	0.6	0.6	0.55	0.35	2.8
(24) LEEK										
Foumban	Production	(ton)	46	45	47	102	980	99	84	43
	Area	(ha)	31	30	2,170	460	43	44	42	86
	Yield	(t/ha)	1.5	1.5	0.02	0.2	2.3	2.25	2.0	0.5
Foumbot	Production	(ton)	186	180	189	408	3,920	396	336	171
	Area	(ha)	123	120	8,680	1,840	172	176	168	344
	Yield	(t/ha)	1.5	1.5	0.02	0.2	5.7	2.25	2.0	0.5
Massangam	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Magba	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Malantouen	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Noun Total	Production	(ton)	232	225	236	510	4,900	495	420	214
	Area	(ha)	154	150	10,850	2,300	215	220	210	430
	Yield	(t/ha)	1.5	1.5	21.75	0.2	22.8	2.25	2	0.5

Table 5.2(13/14) PLANTED AREA, YIELD AND PRODUCTION TO CROPS IN NOUN DIVISION

Sub-division			Crop Year							
			1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
(25) CELERY										
Foumban	Production	(ton)	0.03	0.09	0.5	10	10	10	5	4
	Area	(ha)	0.07	8	4	5	4	4	4	5
	Yield	(t/ha)	0.4	0.01	0.1	2	2.5	2.5	1.25	0.8
Foumbot	Production	(ton)	1.5	4.6	23.5	490	470	471	245	177
	Area	(ha)	3.6	404	176	225	196	196	176	247
	Yield	(t/ha)	0.4	0.01	0.1	2.2	2.4	2.4	1.4	0.7
Massangam	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Magba	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Malantouen	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Noun Total	Production	(ton)	1.55	4.7	24	500	480	481	250	181
	Area	(ha)	1.55	412	180	230	200	200	180	252
	Yield	(t/ha)	1.0	1.1	0.1	2.2	2.4	2.4	1.4	0.7
(26) PUMPKIN										
Foumban	Production	(ton)	4	4.6	1	20	16	5	18	17
	Area	(ha)	2	2	9	18	16	16	17	18
	Yield	(t/ha)	2.0	2.3	0.1	1.1	1.0	0.3	1.05	0.9
Foumbot	Production	(ton)	77	87.3	100	385	299	285	342	315
	Area	(ha)	36	37	167	332	309	309	313	347
	Yield	(t/ha)	2.1	2.35	0.6	1.15	0.95	0.9	1.09	0.9
Massangam	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Magba	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Malantouen	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Noun Total	Production	(ton)	81	91.9	101	405	315	290	360	332
	Area	(ha)	38	39	176	350	325	325	330	265
	Yield	(t/ha)	2.1	2.35	0.6	1.15	0.95	0.9	1.09	0.9

Table 5.2(14/14) PLANTED AREA, YIELD AND PRODUCTION TO CROPS IN NOUN DIVISION

Sub-division			Crop Year 1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
(27) RED PEPPER										
Foumban	Production	(ton)	3	3	7.4	18	18	18	20	138
	Area	(ha)	13	14	75	135	137	137	138	38
	Yield	(t/ha)	0.2	0.2	0.1	0.1	0.1	0.1	0.1	3.6
Foumbot	Production	(ton)	6	7	17.3	42	42	43	45	323
	Area	(ha)	32	33	155	315	319	320	322	87
	Yield	(t/ha)	0.2	0.2	0.1	0.1	0.1	0.1	0.1	3.7
Massangam	Production	(ton)	5	6	14.8	36	36	37	39	277
	Area	(ha)	27	29	150	270	274	275	276	75
	Yield	(t/ha)	0.2	0.2	0.1	0.1	0.1	0.1	0.1	3.7
Magba	Production	(ton)	2	2	5.6	14	15	15	16	111
	Area	(ha)	11	11	60	108	109	110	110	30
	Yield	(t/ha)	0.2	0.2	0.09	0.1	0.1	0.1	0.1	3.7
Malantouen	Production	(ton)	2	1	4	10	10	10	10	74
	Area	(ha)	7	8	40	72	73	73	74	20
	Yield	(t/ha)	0.3	0.1	0.1	0.1	0.1	0.1	0.1	3.7
Noun Total	Production	(ton)	18	19	49.1	120	121	123	130	923
	Area	(ha)	90	95	480	900	912	915	920	250
	Yield	(t/ha)	0.2	0.2	0.1	0.1	0.1	0.1	0.1	3.7
(28) BEET ROOT										
Foumban	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Foumbot	Production	(ton)	70	69	104	250	169	165	150	355
	Area	(ha)	35	34.5	380	535	400	395	350	152
	Yield	(t/ha)	2.0	2.0	0.3	0.45	0.4	0.4	0.4	2.3
Massangam	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Magba	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Malantouen	Production	(ton)	-	-	-	-	-	-	-	-
	Area	(ha)	-	-	-	-	-	-	-	-
	Yield	(t/ha)	-	-	-	-	-	-	-	-
Noun Total	Production	(ton)	70	69	104	250	169	165	150	355
	Area	(ha)	35	34.5	380	535	400	395	350	152
	Yield	(t/ha)	2.0	2.0	0.3	0.45	0.4	0.4	0.4	2.3

Table 5.3 RESULTS OF RICE YIELD OBTAINED BY EXPERIMENT PLOT NO. 2

(Unit yield: ton/ha)

Variety	Height (cm)	Day to 50 % Flowering (day)	Replication			Mean
			A	B	C	
Tainan 5	91	119	5.9	8.2	7.2	7.1
5235-28L2	96	111	6.1	6.2	7.2	6.5
5236-29L1	91	112	6.4	7.8	7.8	7.3
5237-29L17	88	115	6.0	9.5	5.8	7.1
5238-29L35	88	114	10.5	6.6	6.3	7.8
22L1-P	93	115	9.7	5.9	7.3	7.6
5256	87	112	4.5	4.2	4.4	4.4
5259	96	115	9.0	7.7	11.8	9.5
5268	93	114	7.5	10.7	11.6	9.9
5273	96	118	8.9	8.5	7.4	8.3
61-4-2	83	120	10.7	5.1	7.5	7.8
116-10	93	115	7.6	6.6	7.3	7.1
MR-10	71	136	4.1	7.8	3.2	3.7
MR-15	74	126	8.2	4.3	7.3	6.6
CICA-8	66	128	4.4	5.1	5.6	5.0
IR3273	65	125	5.8	5.7	4.3	5.3
IR5867	94	104	7.2	5.0	8.4	6.8
RPKN 2	97	110	4.5	6.1	4.1	4.9
ESSIMBI	70	121	6.6	10.6	10.7	9.3
IR7167-33-2-3-3	89	115	6.5	8.3	6.4	7.1
IR2061-522-6	67	110	4.6	5.5	3.7	4.6
IRAT 130	95	126	6.1	10.1	7.2	7.8
Kaoshung-139	89	121	7.9	7.1	6.0	7.0
Suweon 222	74	94	5.4	5.9	7.9	6.4

Note: Sowing : June 15, 1982
Transplanting : August 1, 1982
Spacing (cm) : 30 x 15
Replication : 3
Fertilizers (kg/ha) : N : P : K = 80 : 120 : 60
Harvesting : Dec. 16, 1982 - Jan. 5, 1983

Table 5.4 (1/4) OBSERVATION RECORD ON WATER TEMPERATURE

Date	Air Temperature			Canal Water Temperature		Field Water Temperature		Ndoup River Water Temperature	
	Max.	Min.	9 o'clock	Max.	Min.	Max.	Min.	Max.	Min.
8/ 1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17	23.5	15.0	17.5	20.0	18.0	33.0	17.5		
18	-	-	-	-	-	-	-		
19	21.0	14.0	20.0	20.5	18.0	33.5	17.0		
20	-	-	-	20.0	19.0	29.5	15.5		
21	22.5	13.0	23.0	-	-	32.0	17.0		
22	19.0	12.5	21.5	20.5	18.0	34.0	17.0		
23	26.0	15.0	22.0	21.0	18.0	32.5	17.5		
24	26.5	16.0	23.0	21.0	19.0	37.0	18.0		
25	25.0	16.0	22.0	21.5	18.5	28.0	17.5		
26	23.0	15.0	22.0	22.0	18.0	29.5	16.5		
27	26.5	20.0	24.5	20.5	18.5	36.9	17.5		
28	26.5	15.5	23.5	20.5	18.5	36.0	17.5		
29	26.0	15.0	20.0	21.0	19.0	34.0	17.5		
30	25.0	18.0	22.0	20.0	18.5	28.5	17.0		
31	25.0	19.0	19.0	21.0	19.0	28.5	18.5		

Table 5.4 (2/4) OBSERVATION RECORD ON WATER TEMPERATURE

Date	Air Temperature			Canal Water Temperature		Field Water Temperature		Ndoup River Water Temperature	
	Max.	Min.	9 o'clock	Max.	Min.	Max.	Min.	Max.	Min.
9/ 1	23.5	15.0	22.5	20.0	19.0	25.0	18.5		
2	25.0	19.0	21.5	21.0	18.5	32.0	18.5		
3	25.5	16.5	22.5	20.5	19.0	29.0	18.5		
4	25.5	18.0	21.5	21.0	19.0	30.0	19.0		
5	26.5	19.0	21.5	21.0	19.0	20.0	18.5		
6	24.5	17.0	21.0	21.0	18.5	27.0	17.5		
7	23.0	19.0	20.0	21.0	18.0	25.0	17.5		
8	25.5	15.0	24.0	21.0	18.5	32.0	18.0		
9	22.0	18.0	21.0	21.0	19.0	32.0	18.0		
10	27.0	18.5	20.0	21.0	19.0	32.0	19.0		
11	25.5	16.5	19.0	20.5	19.0	27.5	18.0		
12	26.0	20.5	20.5	21.0	19.0	30.0	18.0		
13	25.0	18.0	19.0	21.0	19.0	27.5	18.5		
14	24.5	16.0	20.0	20.5	19.0	29.0	18.5		
15	26.0	15.0	25.0	21.5	19.0	33.0	18.0		
16	25.0	17.0	18.5	21.0	18.5	27.5	18.0		
17	25.5	16.0	20.5	21.0	18.5	26.5	18.0		
18	21.5	15.0	22.0	21.0	18.5	30.0	17.5		
19	27.0	16.0	21.0	21.0	19.0	31.0	18.5		
20	25.0	16.0	22.5	21.0	18.5	29.5	19.5		
21	26.5	16.0	23.0	21.0	19.0	30.0	19.0		
22	28.0	16.5	18.0	22.0	19.5	32.5	19.5		
23	22.5	16.0	23.5	19.5	19.0	21.0	17.5		
24	26.0	15.0	22.5	21.0	19.0	30.0	18.0		
25	20.5	14.5	21.0	20.5	17.0	28.0	17.5		
26	19.5	14.5	21.5	20.0	17.0	26.5	17.5		
27	27.0	13.0	22.0	21.0	17.5	30.0	17.0		
28	27.0	15.5	19.5	20.5	17.5	30.0	18.5		
29	26.5	15.5	20.5	20.0	17.0	27.5	18.0		
30	24.5	18.0	22.0	19.5	18.0	23.0	18.0		

Table 5.4 (3/4) OBSERVATION RECORD ON WATER TEMPERATURE

Date	Air Temperature			Canal Water Temperature		Field Water Temperature		Ndoup River Water Temperature	
	Max.	Min.	9 o'clock	Max.	Min.	Max.	Min.	Max.	Min.
10/ 1	27.5	17.0	19.5	21.0	17.5	28.5	19.0		
2	24.0	18.0	22.5	19.5	18.0	23.5	18.5		
3	25.5	21.0	24.0	20.0	18.0	25.5	18.0		
4	27.5	23.5	19.5	21.5	18.0	31.0	19.5		
5	25.5	20.0	23.5	21.5	18.0	26.5	19.5		
6	28.5	21.5	26.5	23.0	17.5	28.0	18.5		
7	-	-	-	22.0	18.0	28.5	19.5		
8	27.5	15.5	25.5	21.5	19.5	25.0	19.0		
9	29.0	15.5	18.5	21.5	18.0	29.5	18.5		
10	22.5	15.0	19.0	19.5	17.5	21.5	17.5		
11	24.5	15.0	17.0	19.5	17.0	23.5	17.5		
12	23.5	15.5	19.5	19.0	17.0	21.0	17.5		
13	24.0	15.5	19.0	20.0	17.0	22.5	17.5	23.0	18.0
14	25.0	16.0	24.0	20.0	18.5	21.5	18.0	20.0	18.5
15	27.0	15.5	18.5	20.5	17.0	27.5	16.5	20.5	18.5
16	25.0	16.0	21.5	20.0	17.0	22.5	18.5	20.0	18.0
17	26.5	16.5	23.0	20.5	17.5	25.0	18.0	20.0	17.5
18	28.0	17.0	24.0	20.0	18.0	25.0	19.5	20.5	18.5
19	29.0	15.2	24.0	21.5	17.5	25.5	19.5	20.5	18.5
20	-	-	-	21.5	17.5	26.5	19.0	20.5	19.0
21	-	-	-	23.5	17.5	26.5	19.0	20.0	19.0
22	28.5	16.0	23.0	20.0	18.0	24.5	19.5	20.5	19.0
23	28.5	15.5	26.5	21.0	18.0	24.5	19.5	20.0	19.0
24	28.0	15.0	22.5	19.5	18.0	24.0	19.0	20.0	19.0
25	29.0	15.0	21.5	20.0	18.0	24.5	19.5	20.5	19.0
26	27.5	15.5	-	20.0	17.5	24.0	19.0	20.5	19.0
27	29.0	16.0	23.5	20.5	17.5	25.0	19.5	20.0	19.5
28	27.5	16.0	20.0	20.5	18.0	24.5	19.0	20.5	19.5
29	26.5	16.0	25.5	19.0	18.0	23.0	19.0	20.0	19.0
30	29.5	16.0	25.0	20.5	18.0	24.5	19.5	20.5	19.5
31	29.5	16.0	18.0	20.0	18.0	24.5	19.0	20.5	19.0

Table 5.4 (4/4) OBSERVATION RECORD ON WATER TEMPERATURE

Date	Air Temperature			Canal Water Temperature		Field Water Temperature		Ndoup River Water Temperature	
	Max.	Min.	9 o'clock	Max.	Min.	Max.	Min.	Max.	Min.
11/ 1	27.5	17.5	22.5	19.5	18.0	22.0	19.0	20.0	18.5
2	29.5	17.5	23.0	21.5	18.0	25.5	19.5	20.5	19.5
3	27.5	17.0	24.5	20.5	18.0	24.5	20.0	20.5	19.5
4	30.0	16.5	25.5	21.0	18.5	24.5	20.0	20.5	19.5
5	28.5	14.5	24.0	21.0	18.5	24.5	19.0	20.5	19.0
6	27.0	16.0	21.0	20.5	18.0	23.0	19.0	20.5	19.0
7	27.5	15.0	21.0	20.0	17.5	22.5	18.5	20.5	19.0
8	27.5	16.5	21.0	20.5	18.0	23.0	19.0	20.5	19.0
9	22.5	13.5	21.0	19.0	17.0	21.0	17.0	20.0	19.0
10	28.5	15.5	23.0	19.5	17.5	22.0	18.0	20.0	19.0
11	28.5	14.0	24.0	20.0	17.0	23.0	18.0	20.0	19.0
12	29.0	15.0	24.5	20.0	17.5	22.5	18.0	20.0	19.5
13	27.5	15.0	25.5	20.0	17.5	24.0	18.0	20.0	19.0
14	29.5	13.0	21.0	20.0	17.0	24.5	15.5	20.5	18.5
15	29.0	15.0	24.0	19.0	17.0	23.5	18.5	20.0	19.0
16	28.0	15.5	22.5	20.0	17.5	24.5	18.0	20.5	19.0
17	29.0	15.0	24.0	20.0	17.5	23.5	18.0	20.5	18.5
18	29.5	12.0	23.5	20.0	17.0	24.5	15.5	20.0	18.0
19	29.0	15.5	24.0	20.0	17.5	24.0	16.0	20.0	18.5
20	30.0	13.0	23.0	19.5	17.0	24.0	16.5	20.0	18.5

Table 5.5 ANTICIPATED CROP PRODUCTION AT FULL DEVELOPMENT STAGE

Rotation	Crops	Dry season			Rainy season			Year total	
		Planted area	Yield	Production	Planted area	Yield	Production	Planted area	Production
		(ha)	(ton/ha)	(ton)	(ha)	(ton/ha)	(ton)	(ha)	(ton)
1ST	Rice	1,000	5	5,000	1,000	5	5,000	2,000	10,000
	Tomato	500	20	10,000	0	20	0	500	10,000
	Maize	0	4	0	1,000	4	4,000	1,000	4,000
	Soybean	500	2	1,000	0	2	0	500	1,000
	Groundnuts	0	2	0	0	2	0	0	0
2nd	Rice	1,000	5	5,000	1,000	5	5,000	2,000	10,000
	Tomato	500	20	10,000	0	20	0	500	10,000
	Maize	0	4	0	500	4	2,000	500	2,000
	Soybean	0	0	0	0	2	0	0	0
	Groundnuts	500	2	1,000	500	2	1,000	1,000	2,000
Mean	Rice	1,000	5	5,000	1,000	5	5,000	2,000	10,000
	Tomato	500	20	10,000	0	20	0	500	10,000
	Maize	0	4	0	750	4	3,000	750	3,000
	Soybean	250	2	500	0	2	0	250	500
	Groundnuts	250	2	500	250	2	500	500	1,000

Table 5.6 (1/5) PROPOSED FARMING PRACTICES

Rice

(Requirement/ha)

Work Item	Labour (man/day)	Machinery & Equipment	Inputs
1. Seed & nursey preparation	5	Tiller: 1 hr.	Seed: 30 kg Urea, T.S.P. & KCℓ : 1 kg each
2. Field preparation			
Tilling	3	Tiller: 15 hrs.	
Puddling	3	Tiller: 5 hrs.	
3. Fertilizing (basal)	2	(man power)	Complex (20-10-10) : 210 kg T.S.P.: 9 kg
4. Transplanting	35	(man power)	
5. Top dressing			
1st	2	(man power)	Urea: 29 kg
2nd	2	(man power)	Urea: 50 kg, T.S.P.: 50 kg
3rd	2	(man power)	Urea: 50 kg
6. Plant protection			
4 times	5/time	Sprayer: 5 hrs./time	Insecticide: 1 ℓ Fungicide : 3 ℓ
7. Weeding			
3 times	5/time	Rotary weeder (man power)	
8. Water management	10		
9. Harvesting, transportation	30		
10. Threshing, drying	10	Thresher: 30 hrs.	
11. Transportation & others	10	Tiller: 20 hrs.	
Total	149	Tiller : 41 hrs. Sprayer : 20 hrs. Thresher: 30 hrs.	Complex: 210 kg Urea : 130 kg T.S.P. : 60 kg KCℓ : 50 kg Fungicide : 3 ℓ Insecticide: 1 ℓ Seed : 30 kg

Table 5.6 (2/5) PROPOSED FARMING PRACTICES

Maize

(Requirement/ha)

Work Item	Labour (man/day)	Machinery & Equipment	Inputs
1. Field preparation			
Tilling	3	Tiller: 15 hrs.	
Ridging	1	Tiller: 5 hrs.	
2. Fertilizing (basal)	2	(man power)	Complex: 380 kg T.S.P. : 90 kg
3. Sowing	10	(man power)	Seed : 25 kg
4. Top dressing			
2 times	2/time	(man power)	Urea : 25 kg/time T.S.P.: 20 kg/time KCℓ : 10 kg/time
5. Plant protection	5	Sprayer: 5 hrs.	Insecticide: 1 ℓ Fungicide : 1 ℓ
6. Weeding, intertilling			
2 times	15/time	(man power)	
7. Water management	10		
8. Harvesting	10		
9. Transportation, drying	10	Tiller: 5 hrs.	
Total	85	Tiller : 25 hrs. Sprayer: 5 hrs.	Complex : 380 kg Urea : 50 kg T.S.P. : 140 kg KCℓ : 20 kg Insecticide: 1 ℓ Fungicide : 1 ℓ Seed : 25 kg

Table 5.6 (3/5) PROPOSED FARMING PRACTICES

Soybean

(Requirement/ha)

Work Item	Labour (man/day)	Machinery & Equipment	Inputs
1. Field preparation			
Tilling	3	Tiller: 15 hrs.	
Ridging	1	Tiller: 5 hrs.	
2. Fertilizing (basal)	2	(man power)	T.S.P.: 220 kg KCℓ : 160 kg
3. Sowing	10	(man power)	Seed : 40 kg
4. Weeding			
2 times	15/time		
5. Plant protection	5	Sprayer: 5 hrs.	Insecticide: 1 ℓ Fungicide : 1 ℓ
6. Water management	10		
7. Harvesting	20		
8. Threshing, drying	10	Thresher: 20 hrs.	
9. Transportation & others	10	Tiller: 5 hrs.	
Total	102	Tiller : 25 hrs. Thresher: 20 hrs. Sprayer : 5 hrs.	T.S.P.: 220 kgs KCℓ : 160 kgs Insecticide: 1 ℓ Fungicide : 1 ℓ Seed : 40 kgs

Table 5.6 (4/5) PROPOSED FARMING PRACTICES

Groundnuts

(Requirement/ha)

Work Item	Labour (man/day)	Machinery & Equipment	Inputs
1. Field preparation			
Tilling	3	Tiller: 15 hrs.	
Ridging	1	Tiller: 5 hrs.	
2. Fertilizing (basal)	2	(man power)	T.S.P.: 150 kg KCℓ : 200 kg
3. Sowing	10	(man power)	Seed : 80 kg
4. Weeding, intertilling			
2 times	15/time	(man power)	
5. Fertilizing (top dress)	2	(man power)	T.S.P.: 70 kg KCℓ : 40 kg
6. Plant protection	5	Sprayer: 5 hrs.	Insecticide: 1 ℓ Fungicide : 1 ℓ
7. Water management	10		
8. Digging, drying	30		
9. Threshing, shelling transportation	30	Thresher: 20 hrs. Sheller : 10 hrs. Tiller : 5 hrs.	
Total	124	Tiller : 25 hrs. Thresher: 20 hrs. Sheller : 10 hrs. Sprayer : 5 hrs.	T.S.P.: 220 kg KCℓ : 240 kg Insecticide: 1 ℓ Fungicide : 1 ℓ Seed : 80 kg

Table 5.6(5/5) PROPOSED FARMING PRACTICES

Tomato

(Requirement/ha)

Work Item	Labour (man/day)	Machinery & Equipment	Inputs
1. Nursey (60 m^2)	20	Tiller: 1 hr.	Seed: 400 g Urea: 10 kg T.S.P.: 5 kg KCℓ : 8 kg
2. Field preparation			
Tilling	3	Tiller: 15 hrs.	
Ridging	1	Tiller: 5 hrs.	
3. Fertilizing (basal)	2	(man power)	Compex: 195 kg T.S.P.: 20 kg KCℓ : 98 kg
4. Transplanting	30	(man power)	
5. Fertilizing (top dressing)			
1st time			Urea: 28 kg, T.S.P. : 26 kg, KCℓ: 21 kg
2nd time			Urea: 57 kg, T.S.P. : 22 kg, KCℓ: 16 kg
3rd time			Urea: 33 kg
4th time			Urea: 33 kg
6. Plant protection			
5 times	5/time	Sprayer: 5/time	Insecticide: 1 ℓ/time Fungicide : 1 ℓ/time
7. Weeding, intertilling			
3 times	15/time		
8. Water management	10		
9. Harvesting	150		
10. Transportation & others	10	Tiller: 20 hrs.	
Total	300	Tiller : 41 hrs. Sprayer: 20 hrs.	Seed : 400 g Complex: 195 kg Urea : 161 kg T.S.P. : 53 kg KCℓ : 143 kg Insecticide: 4 ℓ Fungicide : 4 ℓ

Table 5.7(1/2) FARM BUDGET OF TYPICAL FARM HOUSEHOLD

Farm Size: 2.1 ha 1st rotation

				Amount (CFA F 1,000)
1.	Gross Agricultural Income	Planted Area (ha)		
	- Rice	2.10		819
	- Maize	1.05		294
	- Soybean	0.525		105
	- Tomato	0.525		840
	- Groundnuts	0.0		0
	Total	4.2		2,058
		Quantity	Unit Price (CFA F)	
2.	Production Cost			
	- Seed			11.3
	- Fertilizer			
	Urea	410.0 kg	145	59.5
	TSP	416.3 kg	130	54.1
	KCl	285.1 kg	107	30.5
	20:10:10	942.4 kg	95	89.5
	12: 5:20	0.0 kg	106	0.0
	- Agro-chemical			
	Fungicides	10.0 kg	1,500	15.0
	Insecticides	5.8 ℓ	2,950	17.0
	- Machinery			
	Tiller	147.0 hrs	2,000	294.0
	Sprayer	60.4 hrs	1,200	72.5
	Thresher	73.5 hrs	1,200	88.2
	- Hired Labor	79 man/day	830	65.6
	- Miscellaneous (5% of the aboves)			39.9
	Total			797.2
3.	Net Agricultural Income			1,260.8
4.	O & M Service Charge			382.0
5.	Disposable Income			898.8

Table 5.7(2/2) FARM BUDGET OF TYPICAL FARM HOUSEHOLD

Farm Size: 2.1 ha — 2nd rotation

				Amount (CFA F 1,000)
1.	Gross Agricultural Income	Planted Area (ha)		
	- Rice	2.10		819
	- Maize	0.525		147
	- Soybean	0		0
	- Tomato	0.525		840
	- Groundnuts	1.05		399
	Total	4.2		2,205
		Quantity	Unit Price (CFA F)	
2.	Production Cost			
	- Seed			15.0
	- Fertilizer			
	Urea	383.8 kg	145	55.6
	TSP	458.3 kg	130	59.6
	KCl	442.6 kg	107	47.4
	20:10:10	742.9 kg	95	70.6
	12: 5:20	0.0	106	0.0
	- Agro-chemical			
	Fungicides	10.0 kg	1,500	15.0
	Insecticides	5.8 ℓ	2,950	17.0
	- Machinery			
	Tiller	147.0 hrs	2,000	294.0
	Sprayer	60.4 hrs	1,200	72.5
	Thresher	84.0 hrs	1,200	100.8
	- Hired Labor	105 man/day	830	87.2
	- Miscellaneous (5% of the aboves)			41.7
	Total			834.7
3.	Net Agricultural Income			1,370.3
4.	O& M Service Charge			382.0
5.	Disposable Income			988.3

Table 5.8 FARM MACHINERY OPERATION COST

Item	Machinery		
	Tiller	Sprayer	Thresher
1. Specification	Two wheel, diesel engine of 10 Hp	Portable, diesel engine of 3-4 pH, levee-nozzle.	Auto feed, diesel engine 3-4 Hp
2. Useful life	1,200 hrs.	800 hrs.	800 hrs.
3. Prices	CFA F 1,318,000 (with attachment)	CFA F 682,000	CFA F 596,000
4. Residual value	0	0	0
5. Total annual maintenance coefficiency	50%	30%	50%
6. Fuel consumption (diesel)	2ℓ/hr	0.4ℓ/hr.	0.4ℓ/hr.
7. Unit price of fuel	CFA F 140/ℓ	CFA F 140/ℓ	CFA F 140/ℓ
8. Lubricants	about 30% of the fuel cost	about 30% of the fuel cost	about 30% of the fuel cost
Operation cost/hr.	CFA F 2,011 ≑ CFA F 2,000	CFA F 1,182 ≑ CFA F 1,200	CFA F 1,191 ≑ CFA F 1,200

Table 5.9 ECONOMIC PRICE OF RICE/PADDY, 1995

(Import Parity Price, 1985 Constant)

Item	Operation	US$/t	CFA F/t
1) World export price /1 (Thai 5% broken, FOB Bangkok, 1983 Constant)		327	
2) Adjusted to 1985 Constant	(97.7%)	319	
3) Quality adjustment /2	(-10%)	287	
4) Freight and insurance (Bangkok - Douala)		+184.6	
5) CIF at Douala port		471.6	235,330 /3
6) Wharfage, unloading/loading, handling and storage costs /4			+7,060
7) Inland transportation cost (Douala - Foumbot)			+8,500
8) Store-gate price at Foumbot			250,890
9) Local transportation cost (Foumbot - Project site)			-500
10) Ex-mill gate price at Baigom			250,390
11) Conversion to paddy	(65%)		162,750
12) Milling cost			-8,140
13) Value of by-product			+3,000
14) Local storage losses	(-5%)		-7,880
15) Transportation cost (Farm to rice mill)			-150
16) Economic farm-gate price			149,580
	(Rounded)		150,000

Remarks: /1 Price in 1995 at 1983 constant US dollar forecasted in the document of the World Bank, July 1985; Half-Yearly Revision of Commodity Price Forecasts and Quarterly Review of Commodity Markets for June 1985.

/2 Quality discount from 5% broken to 25-35% broken.

/3 Border price was converted at the shadow rate of US$1.0 = CFA F 499 (Standard conversion factor: 0.77).

/4 Estimated based on the actual costs in 1985/86.

TAble 5.10 ECONOMIC PRICE OF MAIZE, 1995
(Import Parity Price, 1985 Constant)

Item	Operation	US$/t	CFA F/t
1) World export price/1 (No. 2, yellow, FOB Gulf ports)		113	
2) Adjusted to 1985 constant	(97.7%)	110	
3) Freight and insurance (US Gulf port - Douala)		+86.3	
4) CIF at Douala Port		196.3	97,950/2
5) Wharfage, unloading/loading, handling and storage costs/3			+2,940
6) Inland transportation Cost (Douala - Foumbot)			8,500
7) Store-gate price at Foumbot			109,390
8) Local storage losses	(-5%)		-5,470
9) Local transportation cost (Foumbot - Project site - Farm)			-650
10) Economic farm gate price			103,270
	(Rounded)		103,000

Remarks: /1 Price in 1995 at 1983 constant US dollar forecasted in the document of the World Bank, July 1985; Half-Yearly Revision of Commodity Price Forecasts and Quarterly Review of Commodity Markets for June 1985.

/2 Border price was converted at the shadow rate of US$1.0 = CFA F499 (Standard conversion factor: 0.77).

/3 Estimated based on the actual costs in 1985/86.

Table 5.11 ECONOMIC PRICE OF SOYBEANS, 1995
(Import Parity Price, 1985 Constant)

Item	Operation	US$/t	CFA F/t
1) World export price/1 (CIF Rotterdam)		244	
2) Adjusted to 1985 Constant	(97.7%)	238	
3) Freight and insurance (Rotterdam/Europe - Douala)		+135.5	
4) CIF at Douala port		373.5	186,380/2
5) Wharfage, unloading/loading, handling and storage costs/3			+5,590
6) Inland transportation cost (Douala - Foumbot)			+8,500
7) Store-gate price at Foumbot			200,470
8) Local storage losses	(-5%)		-10,020
9) Local transportation cost (Foumbot - Project site - Farm)			-650
10) Economic Farm gate price			189,800
	(Rounded)		190,000

Remarks: /1 Price in 1995 at 1983 constant US dollar forecasted in the document of the World Bank, July 1985; Half-Yearly Revision of Commodity Price Forecasts and Quarterly Review of Commodity Markets for June 1985.

/2 Border price was converted at the shadow rate of US$1.0 = CFA F499.

/3 Estimated based on the actual costs in 1985/86.

Table 5.12 ECONOMIC PRICE OF FERTILIZERS, 1995
(Import Parity Price, 1985 Constant)

Item	Operation	Urea		T.S.P.		KCl	
		US$/t	CFA F/t	US$/t	CFA F/t	US$/t	CFA F/t
1) World export price/1 (1983 constant)		240		150		98	
2) Adjusted to 1985 constant	(97.7%)	235		147		96	
3) Freight and insurance		136		87		94	
4) CIF at Douala port		371	185,130/2	234	116,770/2	190	94,810/2
5) Wharfage, unloading/loading, handling and storage costs/3			+5,550		+3,500		+2,840
6) Inland transportation cost (Douala - Foumbot)			+8,500		+8,500		+8,500
7) Store-gate price at Foumbot			199,180		128,770		106,150
8) Local transportation cost (Foumbot - Project site)			+500		+500		+500
9) Handling and storing cost/4			+9,960		+6,440		+5,310
10) Transport to farm-gate			+150		+150		+150
11) Economic farm-gate price			209,790		135,860		112,110
	(Rounded)		210,000		136,000		112,000

Remarks: /1 Prices in 1995 at 1983 constant US dollar forecasted in the document of the World Bank, July 1985; Half-Yearly Revision of Commodity Price Forecasts and Quarterly Review of Commodity Markets for June 1985.

- Urea : FOB N.W. Europe
- T.S.P.: FOB US Gulf
- KCl : FOB Vancouver

/2 Border prices were converted at shadow rate of US$1.0 = CFA F499.

/3 Estimated based on the actual costs in 1985/86

/4 5% of store-gate price was applied in the estimation.

Table 5.13 ECONOMIC PRICE OF TIMBER, 1990
(Export Parity Price, 1985 Constant)

Item	Operation	US$/CM	CFA F/CM
1) World export price (1983 constant)/1		181	
2) Adjusted to 1985 constant	(97.7%)	177	
3) Quality adjustment/2	(-40%)	106	
4) FOB export price at Douala		106	52,890/3
5) Wharfage, unloading/loading handling and storage costs/4			-1,590
6) Inland transportation cost (Douala - Foumbot)			-21,000
7) Market price at Foumbot			30,300
8) Handling and transportation cost (Foumbot - Project site)	(5%)		-1,520
9) Economic farm-gate price			28,780
	(Rounded)		28,800

Remarks:

/1 Prices in 1990 at 1983 constant US dollar forecasted in the document of the World Bank, July 1985; Half-Yearly Revision of Commodity Price Forecasts and Quarterly Review of Commodity Markets for June 1985.

/2 Quality discount from high quality (Sapelli) to the average of the marketable timbers

/3 Border price was converted at the shadow rate of US$1.0 = CFA F499 (Standard conversion factor: 0.77)

/4 Estimated based on the actual costs in 1985/86.

/5 5% of market price was applied in the estimation

Table 5.14 FINANCIAL AND ECONOMIC PRICES OF AGRICULTURAL OUTPUTS AND INPUTS (Price Level on November, 1985)

Outputs and Inputs		Financial Price (1985)/1	Economic Price (1985)/2
Outputs			
- Paddy (Unhulled)	(CFA F/Kg)	78	150
- Rice (retail price)		200	-
- Maize (Shelled)	(")	70	103
- Soybeans (")	(")	100	190
- Tomato		80	80
- French beans (green)		110	110
- Groundnuts (Shelled)		200	200
- Timber			
- Diameter 50 cm	(CFA F/m)	25,700	28,800
- Diameter 20 - 50 cm	(")	10,100	7,800
- Firewood	(")	1,000	770
Inputs			
(1) Seed/4			
- Paddy	(CFA F/Kg)	78	100
- Maize		70	64
- Soybeans		100	133
- Tomato			
- Frenchbeans		160	160
- Groundnuts		200	200
(2) Fertilizer			
- Urea	(CFA F/Kg)	145	210
- T.S.P.		130	136
- KCl		107	112
(3) Agro-chemicals/5			
- Liquid	(CFA F/ℓ)	2,950	2,800
- Granular	(CFA F/Kg)	1,500	1,400
(4) Labor/6	(CFA F/day)	830	600

Remarks: /1 As of December, 1985

/2 1995 projection prices at 1985 constant

/3 Estimated according to the average market prices given in the "Marchés et Méditerranéens" publication and official documents on forest exploitation supplied by the Ministry of Agriculture.

/4 Prices of farm outputs were applied to those of seeds.

/5 Economic price of agro-chemicals were estimated as below:

EP = FP x SP x 1R

EP: Economic price of agro-chemicals
FP: Financial price of agro-chemicals
SP: Conversion factor for shadow price (0.77)
1R: Average increased rate of prices of fertilizers from 1985 to 1995 (1.25)

Item	1985 Constant Price 1985 (US$/t)	1985 Constant Price 1995 (US$/t)	Average Increased Rate
Urea	168	235	1.399
T.S.P.	118	147	1.246
KCl	86	96	1.116
Average			1.25

(Source: IBRD Price Projection)

/6 Shadow wage rate: 0.72
Estimated based on the ralary list of the Government and the shadow price (CFA F600 per man-day) of farm labor applied by the World Bank Report on "Second Western Province Rural Development Project", March 1984.

* Farm-gate or market prices as of November 1985.

Table 5.15 (1/5) CROP BUDGET WITH PROJECT CONDITION

(Rice)

	Economic Unit Price	Quantity	Economic Total Amount	Financial Unit Price	Financial Total Amount
	(CFA F)		(CFA F 1,000)	(CFA F)	(CFA F 1,000)
A. Gross Production Value Unit Yield (Kg/ha)	150/Kg	5,000	750.0	78	390.0
B. Production Cost					
1. Seed	100/Kg	30	3.0	78	2.3
2. Fertilizer					
- Urea	210/Kg	130	27.3	145	18.9
- TSP	136/Kg	60	8.2	130	7.8
- KCl	112/Kg	50	5.6	107	5.4
- 20:10:10	91/Kg	210	19.1	95	20.0
- 12: 5:20	102/Kg	0	0.0	106	0.0
3. Agro-chemical					
- Fungicides	1,400/lit	3	4.2	1,500	4.5
- Insecticides	2,800/lit	1	2.8	2,950	3.0
4. Machinery Requirement					
- Tiller	2,000/hour	41	82.0	2,000	82.0
- Sprayer	1,200/hour	20	24.0	1,200	24.0
- Thresher	1,200/hour	30	36.0	1,200	36.0
5. Labor Requirement (Family only)	600/man-day	149	89.4	830	0.0
6. Miscellaneous (5%)			15.1		10.2
Sub-total			316.7		214.1
7. Net Production Value			433.3		175.9

Table 5.15 (2/5) CROP BUDGET WITH PROJECT CONDITION

(Maize)

	Economic Unit Price	Quantity	Economic Total Amount	Financial Unit Price	Financial Total Amount
	(CFA F)		(CFA F 1,000)	(CFA F)	(CFA F 1,000)
A. Gross Production Value Unit Yield (Kg/ha)	103/Kg	4,000	412.0	70	280.0
B. Production Cost					
1. Seed	64/Kg	25	1.6	70	1.8
2. Fertilizer					
- Urea	210/Kg	50	10.5	145	7.3
- TSP	136/Kg	150	19.0	130	18.2
- KCl	112/Kg	20	2.2	107	2.1
- 20:10:10	91/Kg	380	.	95	36.1
- 12: 5:20	102/Kg	0		106	0.0
3. Agro-chemical					
- Fungicides	1,400/lit	1	1.4	1,500	1.5
- Insecticides	2,800/lit	1	2.8	2,950	3.0
4. Machinery Requirement					
- Tiller	2,000/hour	25	50.0	2,000	50.0
- Sprayer	1,200/hour	5	6.0	1,200	6.0
- Thresher	1,200/hour	0	0.0	1,200	0.0
5. Labor Requirement (Family only)	600/man-day	85	51.0	830	0.0
6. Miscellaneous (5%)			7.2		6.3
Sub-total			151.7		132.3
7. Net Production Value			260.3		147.7

Table 5.15 (3/5) CROP BUDGET WITH PROJECT CONDITION
(Groundnuts)

	Economic Unit Price	Quantity	Economic Total Amount	Financial Unit Price	Financial Total Amount
	(CFA F)		(CFA F 1,000)	(CFA F)	(CFA F 1,000)
A. Gross Production Value Unit Yield (Kg/ha)	200/Kg	2,000	400.0	190	380.0
B. Production Cost					
1. Seed	200/Kg	80	16.0	80	6.4
2. Fertilizer					
- Urea	210/Kg	0	0.0	145	0.0
- TSP	136/Kg	220	29.9	130	28.6
- KCl	112/Kg	240	26.9	107	25.7
- 20:10:10	91/Kg	0		95	0.0
- 12: 5:20	102/Kg	0		106	0.0
3. Agro-chemical					
- Fungicides	1,400/lit	1	1.4	1,500	1.5
- Insecticides	2,800/lit	1	2.8	2,950	3.0
4. Machinery Requirement					
- Tiller	2,000/hour	25	50.0	2,000	50.0
- Sprayer	1,200/hour	5	6.0	1,200	6.0
- Thresher	1,200/hour	20	24.0	1,200	24.0
- Sheller	1,200/hour	10	12.0	1,200	12.0
5. Labor Requirement	600/man-day	124	74.4	830	0.0
6. Miscellaneous (5%)			12.2		7.9
Sub-total			255.6		165.1
7. Net Production Value			144.4		214.9

Table 5.15 (4/5) CROP BUDGET WITH PROJECT CONDITION

(Soybean)

	Economic Unit Price	Quantity	Economic Total Amount	Financial Unit Price	Financial Total Amount
	(CFA F)		(CFA F 1,000)	(CFA F)	(CFA F 1,000)
A. Gross Production Value Unit Yield (Kg/ha)	190/Kg	2,000	380.0	100	200.0
B. Production Cost					
1. Seed	133/Kg	40	5.3	100	4.0
2. Fertilizers					
- Urea	210/Kg	0	0.0	145	0.0
- TSP	136/Kg	220	29.9	130	28.6
- KCl	112/Kg	160	17.9	107	17.1
- 20:10:10	91/Kg	0		95	0.0
- 12: 5:20	102/Kg	0		106	0.0
3. Agro-chemicals					
- Fungicides	1,400/lit	1	1.4	1,500	1.5
- Insecticides	2,800/lit	1	2.8	2,950	3.0
4. Machinery Requirement					
- Tiller	2,000/hour	25	50.0	2,000	50.0
- Sprayer	1,200/hour	5	6.0	1,200	6.0
- Thresher	1,200/hour	20	24.0	1,200	24.0
5. Labor Requirement (Family only)	600/man-day	102	61.2	830	0.0
6. Miscellaneous (5%)			9.9		6.7
Sub-total			208.4		140.9
7. Net Production Value			171.6		59.1

Table 5.15 (5/5) CROP BUDGET WITH PROJECT CONDITION

(Tomato)

	Economic Unit Price	Quantity	Economic Total Amount	Financial Unit Price	Financial Total Amount
	(CFA F)		(CFA F 1,000)	(CFA F)	(CFA F 1,000)
A. Gross Production Value Unit Yield (Kg/ha)	80/Kg	20,000	1,600.0	80	1,600.0
B. Production Cost					
1. Seed	12,000/Kg	0.4	4.8	12,000	4.8
2. Fertilizer					
- Urea	210/Kg	161	33.8	145	23.3
- TSP	136/Kg	53	7.2	130	6.9
- KCl	112/Kg	143	16.0	107	15.3
- 20:10:10	91/Kg	195		95	18.5
- 12: 5:20	102/Kg	0		106	0.0
3. Agro-chemical					
- Fungicides	1,400/lit	4	5.6	1,500	6.0
- Insecticides	2,800/lit	4	11.2	2,950	11.8
4. Machinery Requirement					
- Tiller	2,000/hour	41	82.0	2,000	82.0
- Sprayer	1,200/hour	20	24.0	1,200	24.0
- Thresher	1,200/hour	0	0.0	1,200	0.0
5. Labor Requirement (Family only)	600/man-day	300	180.0	830	0.0
6. Miscellaneous (5%)			18.2		9.6
Sub-total			382.8		202.2
7. Net Production Value			1,217.2		1,397.8

Table 5.16 CROP BUDGET WITHOUT PROJECT CONDITION

		Maize	Groundnuts	Haricotbeans	Tomato	Haricot (green)
1. Gross production value						
Yield	(ton/ha)	2.0	1.0	1.7	2.7	1.3
Unit price	(CFA F/Kg)	64	200	160	80	110
Total value	(CFA F 10^3)	206	200	272	216	143
2. Production cost:						
(1) Seed requirement	(Kg/ha)	25	80	80	0.4	80
Unit price	(CFA F/Kg)	64	200	160	12,000	110
Amount	(CFA F)	1,600	16,000	12,800	4,800	8,800
(2) Fertilizers						
Urea, Requirement	(Kg/ha)	50	-	-	50	-
Unit Price	(CFA F/Kg)	210			210	
Amount	(CFA F)	10,500			10,500	
T.S.P, Requirement	(Kg/ha)	50	-	-	50	-
Unit Price	(CFA F/Kg)	136			136	
Amount	(CFA F)	6,800			6,800	
(3) Labour Requirement	(man/day/ha)	92	154	150	211	150
Unit price	(CFA F/man/day)	600	600	600	600	600
Amount	(CFA F)	55,200	92,400	90,000	122,600	90,000
Sub-total		74,100	108,400	102,800	144,700	98,800
3. Net production value (CFA F) (1 - 2)		131,900	91,600	169,200	71,300	44,200

Table 5.17 EXPECTED ECONOMIC PRODUCTION VALUE WITH PROJECT CONDITION

(Unit: CFA F 10^3)

	1990	1991	1992	1993	1994	1995	1996	1997
Rice/1	46,430	132,510	290,350	595,730	736,150	845,620	909,420	942,570
Maize	8,190	24,090	53,320	111,790	147,840	175,650	195,220	195,220
Tomato	20,860	72,150	166,700	347,000	488,600	568,600	608,600	608,600
Soybean	490	4,075	9,100	20,100	30,550	38,150	42,900	42,900
Groundnuts	220	4,050	10,100	25,200	48,200	62,200	72,200	72,200
Total	76,190	236,875	529,570	1,099,820	1,451,340	1,690,220	1,828,340	1,861,490

/1 : Net production value at mill gate.

Note: Calculation of the values are presented in Table 5.19 (1/5) - (5/5).

Table 5.18 ANNUAL ECONOMIC PRODUCTION VALUE WITHOUT PROJECT CONDITION

Crops	Croppedarea	Net production value	Total production value
	(ha)	(CFAF/ha)	(CFA F 10^3)
Maize	160	131,900	21,104
Groundnuts	160	91,600	14,656
Haricot beans	160	169,200	27,072
Tomato	35	71,300	2,496
Haricot (green)	35	44,200	1,547
Total	550	-	66,875

Table 5.19(1/5) ECONOMIC NET PRODUCTION VALUE OF RICE AT MILL GATE

	1990			1991			1992			1993			1994			1995			1996			1997 and thereafter		
	Yield	Planted area	Production	Yield	Planted area	Production	Yield	Planted area	Production	Yield	Planted area	Production	Yield	Planted area	Production	Yield	Planted area	Production	Yield	Planted area	Production	Yield	Planted area	Production
	3.5	200	700	4.0	200	800	4.5	200	900	4.8	200	960	5.0	200	1,000	5.0	200	1,000	5.0	200	1,000	5.0	200	1,000
	-	-	-	3.5	300	1,050	4.0	300	1,200	4.5	300	1,350	4.8	300	1,440	5.0	300	1,500	5.0	300	1,500	5.0	300	1,500
	-	-	-	-	-	-	3.5	500	1,750	4.0	500	2,000	4.5	500	2,250	4.8	500	2,400	5.0	500	2,500	5.0	500	2,500
	-	-	-	-	-	-	-	-	-	3.5	1,000	3,500	4.0	1,000	4,000	4.5	1,000	4,500	4.8	1,000	4,800	5.0	1,000	5,000
Total	-	200	700	-	500	1,850	-	1,000	3,850	-	2,000	7,810	-	2,000	8,690	-	2,000	9,400	-	2,000	9,800	-	2,000	10,000
White rice/1 (ton)			430			1,140			2,380			4,820			5,370			5,800			6,050			6,180
Mill gate value/3 (CFA F 10^3)			107,670			285,460			595,950			1,206,930			1,344,650			1,452,320			1,514,920			1,547,470
Bran/2 (ton)			70			180			370			740			830			890			930			950
Mill gate value/4 (CFA F 10^3)			2,100			5,400			11,100			22,200			24,900			26,700			27,900			28,500
Total gross economic mill/ gate/value			109,770			290,860			607,050			1,229,130			1,369,550			1,479,020			1,542,820			1,575,970
Production cost/5			63,340			158,350			316,700			633,400			633,400			633,400			633,400			633,400
Net production value at mill gate			46,430			132,510			290,350			595,730			736,150			845,620			909,420			942,570

/1: Storage loss of 5% in the project area and milling recovery of 65% were applied.

/2: Bran production was estimated based on 10% of paddy.

/3: The economic price of CFA F 250,400 per ton.

/4: The economic price of 30 CFA F/Kg was used.

/5: The economic production cost of paddy applied is CFA F 316,700 per hectare.

Table 5.19(2/5) ECONOMIC NET PRODUCTION VALUE OF MAIZE AT FARM GATE

	1990			1991			1992			1993			1994			1995			1996 and thereafter		
	Yield	Planted area	Production	Yield	Planted area	Production	Yield	Planted area	Production	Yield	Planted area	Production	Yield	Planted area	Production	Yield	Planted area	Production	Yield	Planted area	Production
	2.5	75	190	3.0	75	230	3.5	75	260	4.0	75	300	4.0	75	300	4.0	75	300	4.0	75	300
	-	-	-	2.5	112.5	280	3.0	112.5	340	3.5	112.5	390	4.0	112.5	450	4.0	112.5	450	4.0	112.5	450
	-	-	-	-	-	-	2.5	187.5	470	3.0	187.5	560	3.5	187.5	660	4.0	187.5	750	4.0	187.5	750
	-	-	-	-	-	-	-	-	-	2.5	375	940	3.0	375	1,130	3.5	375	1,310	4.0	375	1,500
Total	-	75	190	-	187.5	510	-	375	1,070	-	750	2,190	-	750	2,540	-	750	2,810	-	750	3,000
Gross production value (CFA F 10^3) /1			19,570			52,530			110,210			225,570			261,620			289,430			309,000
Production cost (CFA F 10^3) /2			11,380			28,440			56,890			113,780			113,780			113,780			113,780
Net production value (CFA F 10^3)			8,190			24,090			53,320			111,790			147,840			175,650			195,220

/1: The economic price of maize applied is CFA F 10^3 per Kg at farm gate.

/2: The economic production cost applied is CFA F 151,700 per hectare.

Table 5.19(3/5) ECONOMIC NET PRODUCTION VALUE OF TOMATO AT FARM GATE

	1990			1991			1992			1993			1994			1995			1996 and thereafter		
	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.
	10	50	500	15	50	750	18	50	900	20	50	1,000	20	50	1,000	20	50	1,000	20	50	1,000
				10	75	750	15	75	1,130	18	75	1,350	20	75	1,500	20	75	1,500	20	75	1,500
							10	125	1,250	15	125	1,880	18	125	2,250	20	125	2,500	20	125	2,500
										10	250	2,500	15	250	3,750	18	250	4,500	20	250	5,000
Total	-	50	500	-	125	1,500	-	250	3,280	-	500	6,730	-	500	8,500	-	500	9,500	-	500	10,000
Gross production value /1 (CFA F 10^3)			40,000			120,000			262,400			538,400			680,000			760,000			800,000
Production cost /2 (CFA F 10^3)			19,140			47,850			95,700			191,400			191,400			191,400			191,400
Net production value (CFA F 10^3)			20,860			72,150			166,700			347,000			488,600			568,600			608,600

/1: The economic price applied is CFA F 80 per Kg at farm gate.

/2: The economic production cost applied is CFA F 382,800 per hectare.

Table 5.19(4/5) ECONOMIC NET PFODUCTION VALUE OF SOYBEAN AT FARM GATE

	1990			1991			1992			1993			1994			1995			1996		
	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.
	1.3	25	30	1.6	25	40	1.8	25	45	2.0	25	50	2.0	25	50	2.0	25	50	2.0	25	50
				1.3	37.5	50	1.6	37.5	60	1.8	37.5	70	2.0	37.5	75	2.0	37.5	75	2.0	37.5	75
							1.3	62.5	80	1.6	62.5	100	1.8	62.5	110	2.0	62.5	125	2.0	62.5	125
										1.3	125	160	1.6	125	200	1.8	125	225	2.0	125	250
Total	-	25	30	-	62.5	90	-	125	185	-	250	380	-	250	435	-	250	475	-	250	500
Gross production value /1 (CFA F 10^3)			5,700			17,100			35,150			72,200			82,650			90,250			95,000
Production cost /2 (CFA F 10^3)			5,210			13,025			26,050			52,100			52,100			52,100			52,100
Net production value (CFA F 10^3)			490			4,075			9,100			20,100			30,550			38,150			42,900

/1: The economic price applied is CFA F 190 per Kg at farm gate.

/2: The economic production cost applied is CFA F 208,400 per hectare.

Table 5.19(5/5) ECONOMIC NET PRODUCTION VALUE OF GROUNDNUTS AT FARM GATE

	1990			1991			1992			1993			1994			1995			1996		
	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.
	1.3	50	65	1.6	50	80	1.8	50	90	2.0	50	100	2.0	50	100	2.0	50	100	2.0	50	100
				1.3	75	100	1.6	75	120	1.8	75	135	2.0	75	150	2.0	75	150	2.0	75	150
							1.3	125	160	1.6	125	200	1.8	125	230	2.0	125	250	2.0	125	250
										1.3	250	330	1.6	250	400	1.8	250	450	2.0	250	500
Total	-	50	65	-	125	180	-	250	370	-	500	765	-	500	880	-	500	950	-	500	1,000
Gross production value /1 (CFA F 10^3)			13,000			36,000			74,000			153,000			176,000			190,000			200,000
Production cost /2 (CFA F 10^3)			12,780			31,950			63,900			127,800			127,800			127,800			127,800
Net production value (CFA F 10^3)			220			4,050			10,100			25,200			48,200			62,200			72,200

/1: The economic price applied is CFA F 200 per Kg at farm gate.

/2: The economic production cost applied is CFA F 255,600 per hectare.

Fig. 5.1 PRESENT LAND USE IN PROJECT AREA

Category of Land Use	Study Area (ha)	Project Area (ha)
Forest :	1,200	1,050
Common forest	270	240
Swampy forest	930	810
Grassland :	1,110	1,100
Common grass	440	360
Swampy grass	670	740
Rice field	10	10
Upland field :	450	240
Year round cropping	340	170
Dry season cropping	110	70
Coffee plantation	10	0
Residential area/ others	20	0
Total	2,800	2,400

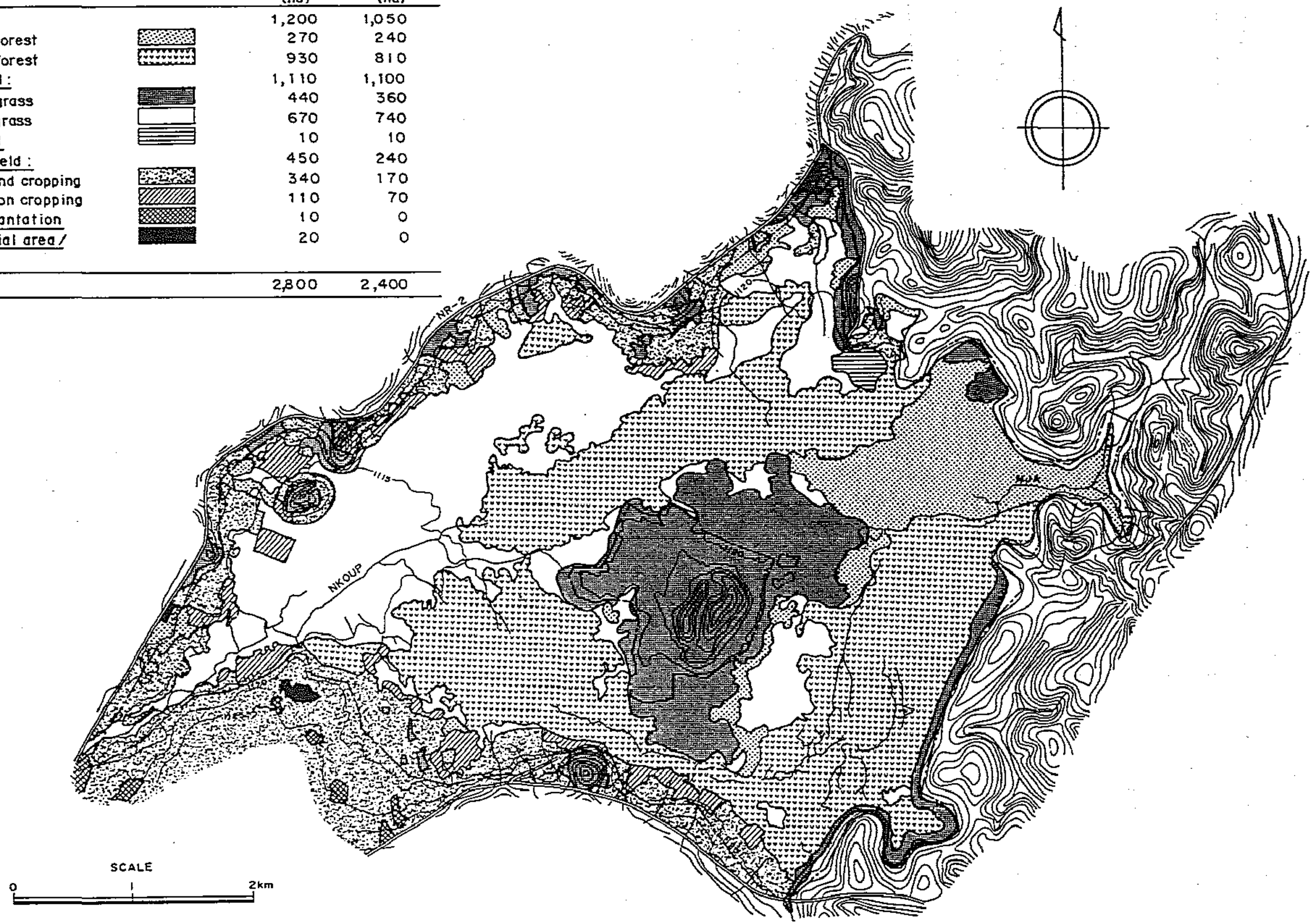


Fig. 5.2 PRESENT CROPPING CALENDAR IN PROJECT AREA

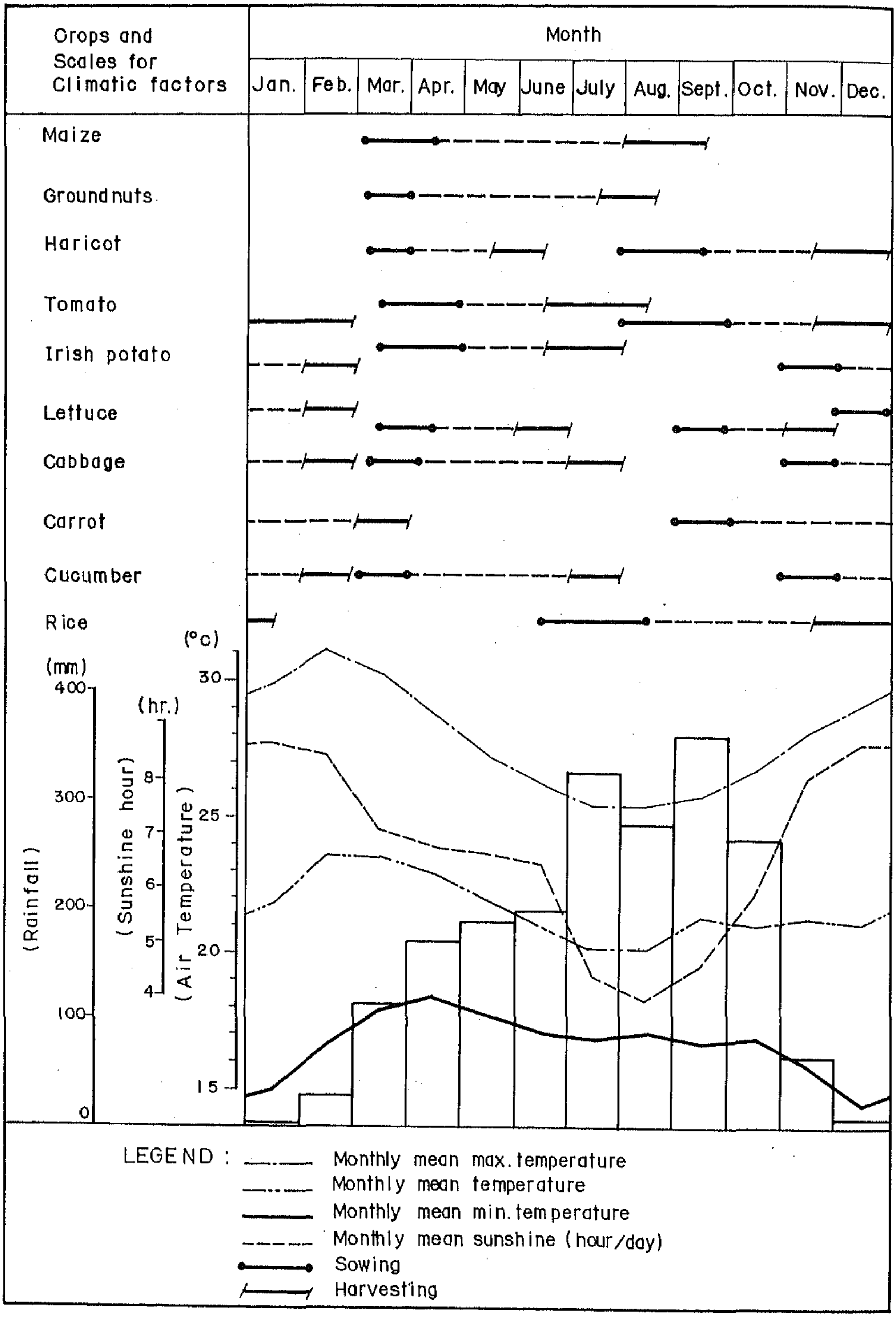


Fig. 5.3 AIR AND WATER TEMPERATURE IN THE FIELD

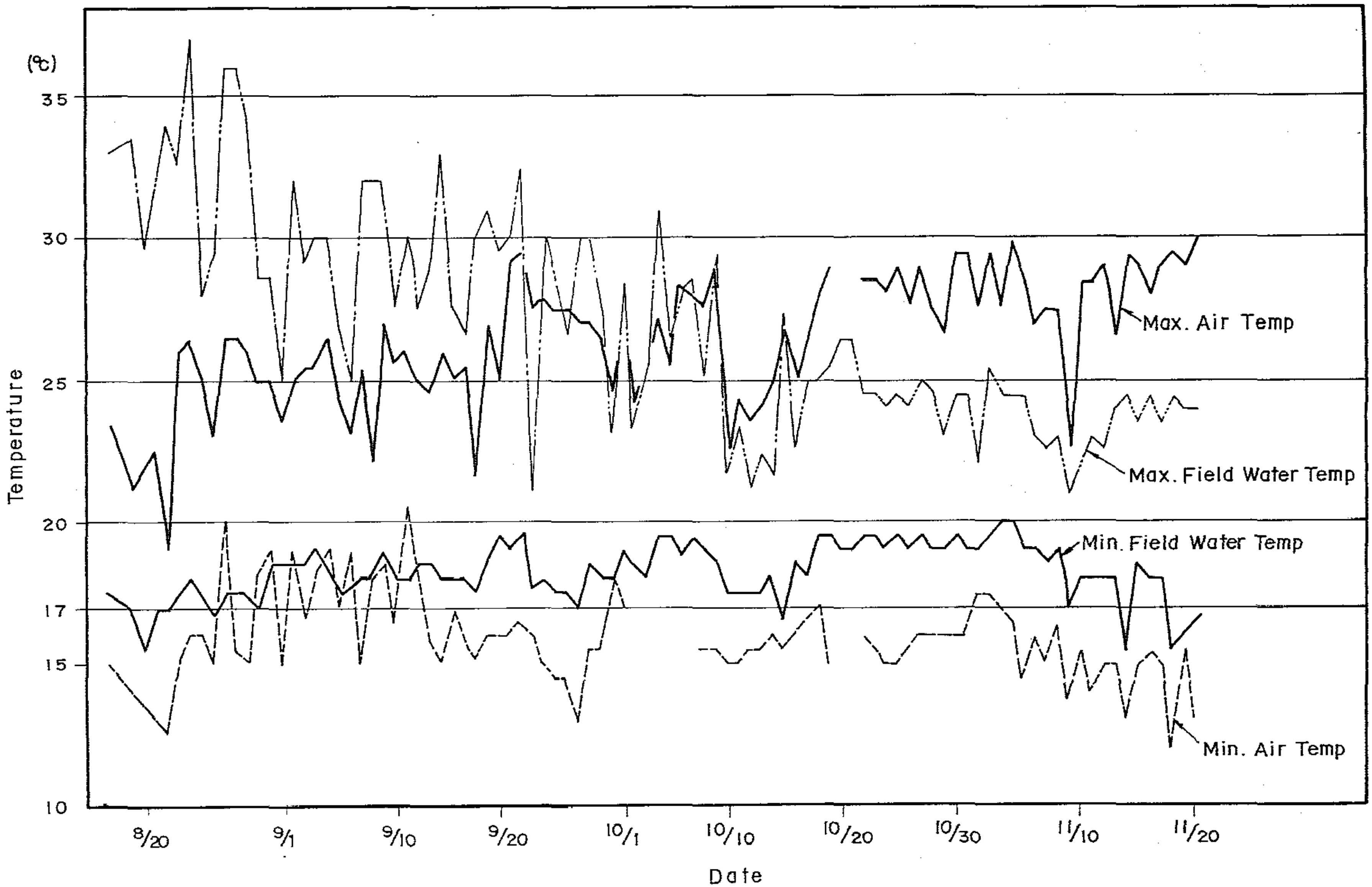
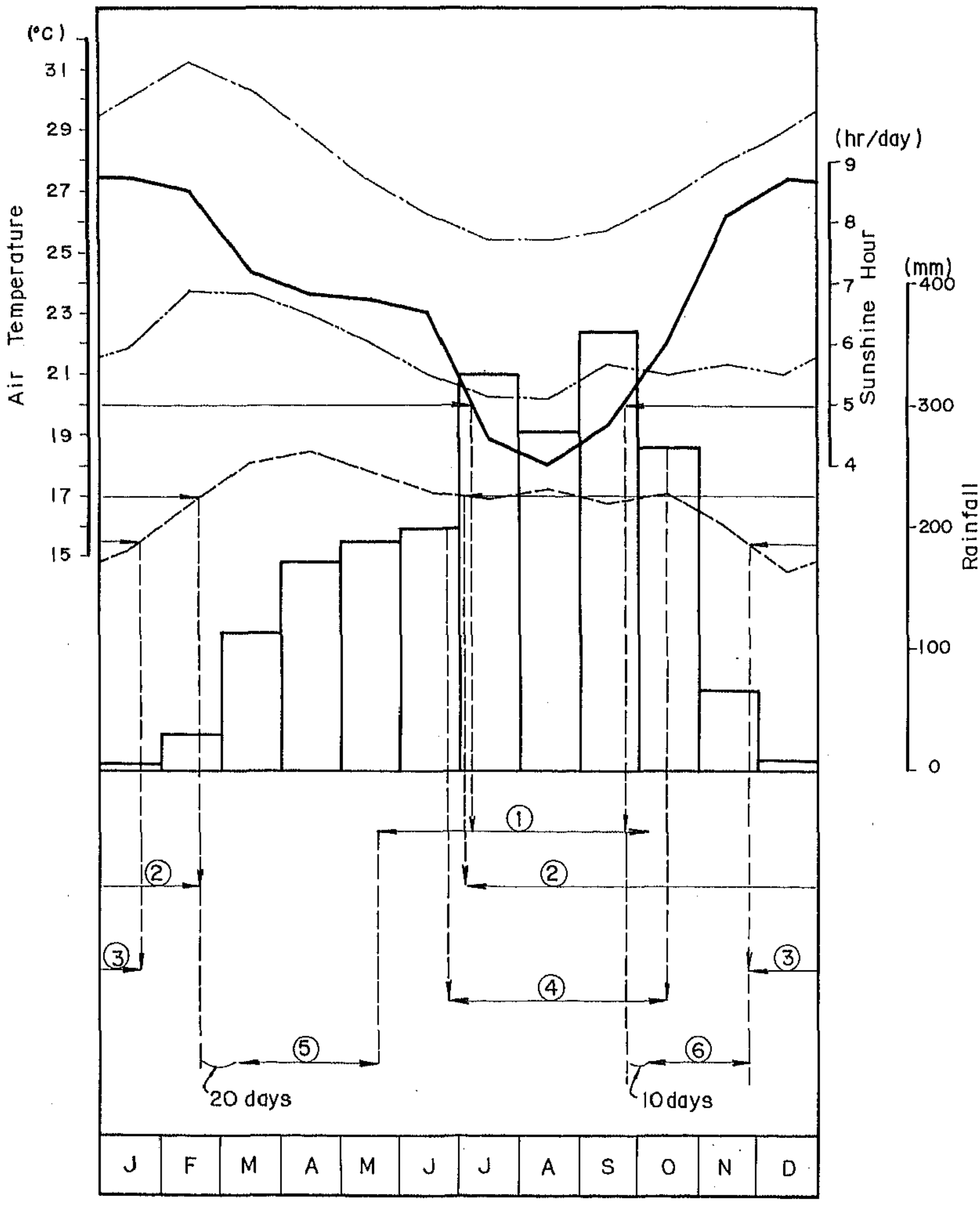


Fig. 5.4 SUITABLE PERIOD FOR GROWING STAGE



① Unsuitable period for heading due to low solar radiation.
② Unsuitable period for young panicle formation and heading due to low temperature.
③ Unsuitable period for flowering due to low temperature.
④ Unsuitable period for harvesting due to much rainfall days.
⑤ Most suitable period for heading.
⑥ Second most suitable period for heading.

Fig. 5.5 PROPOSED CROPPING PATTERN

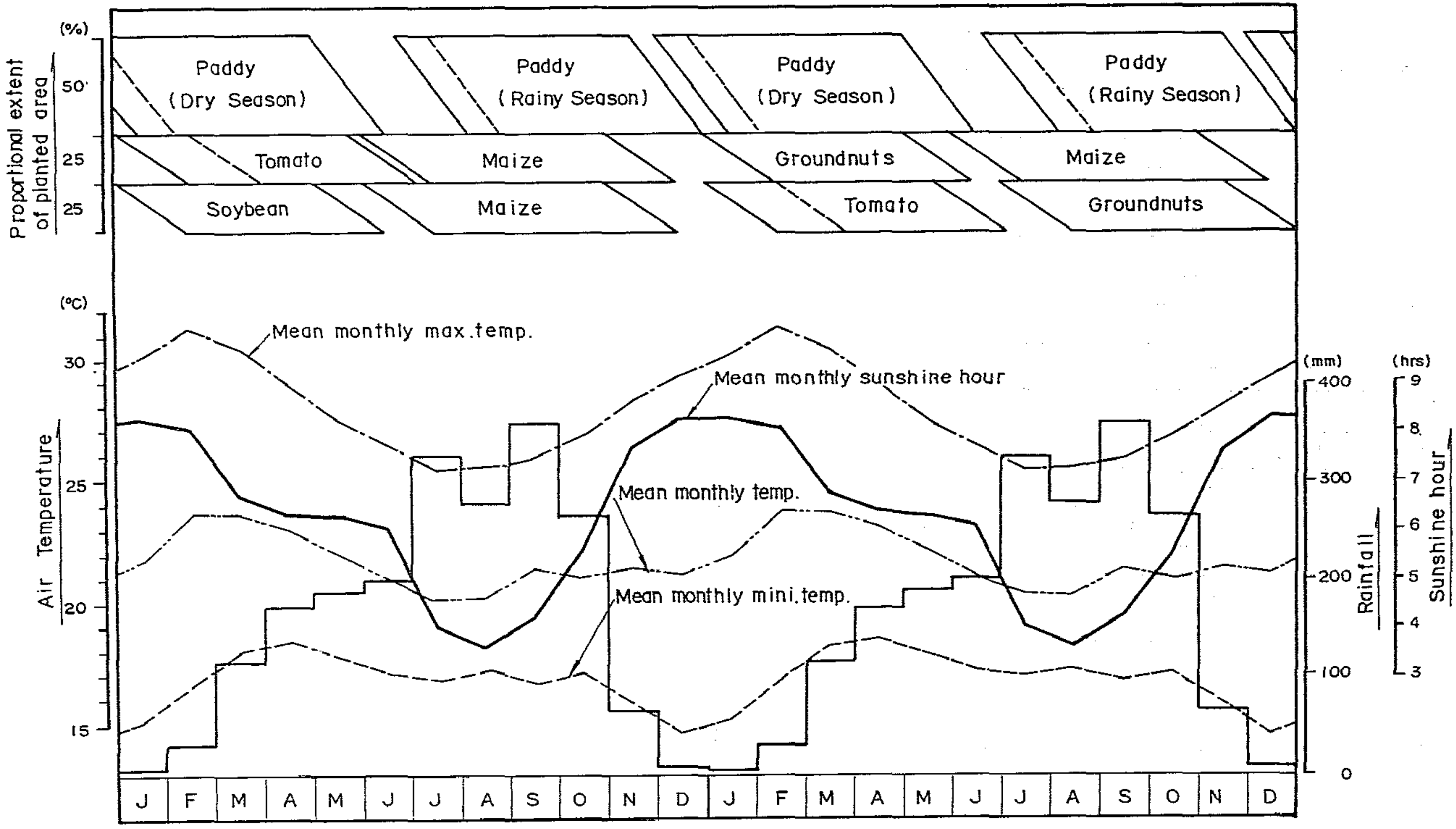


FIG. 5.6 PROCESSING FLOW DIAGRAM OF PADDY/RICE

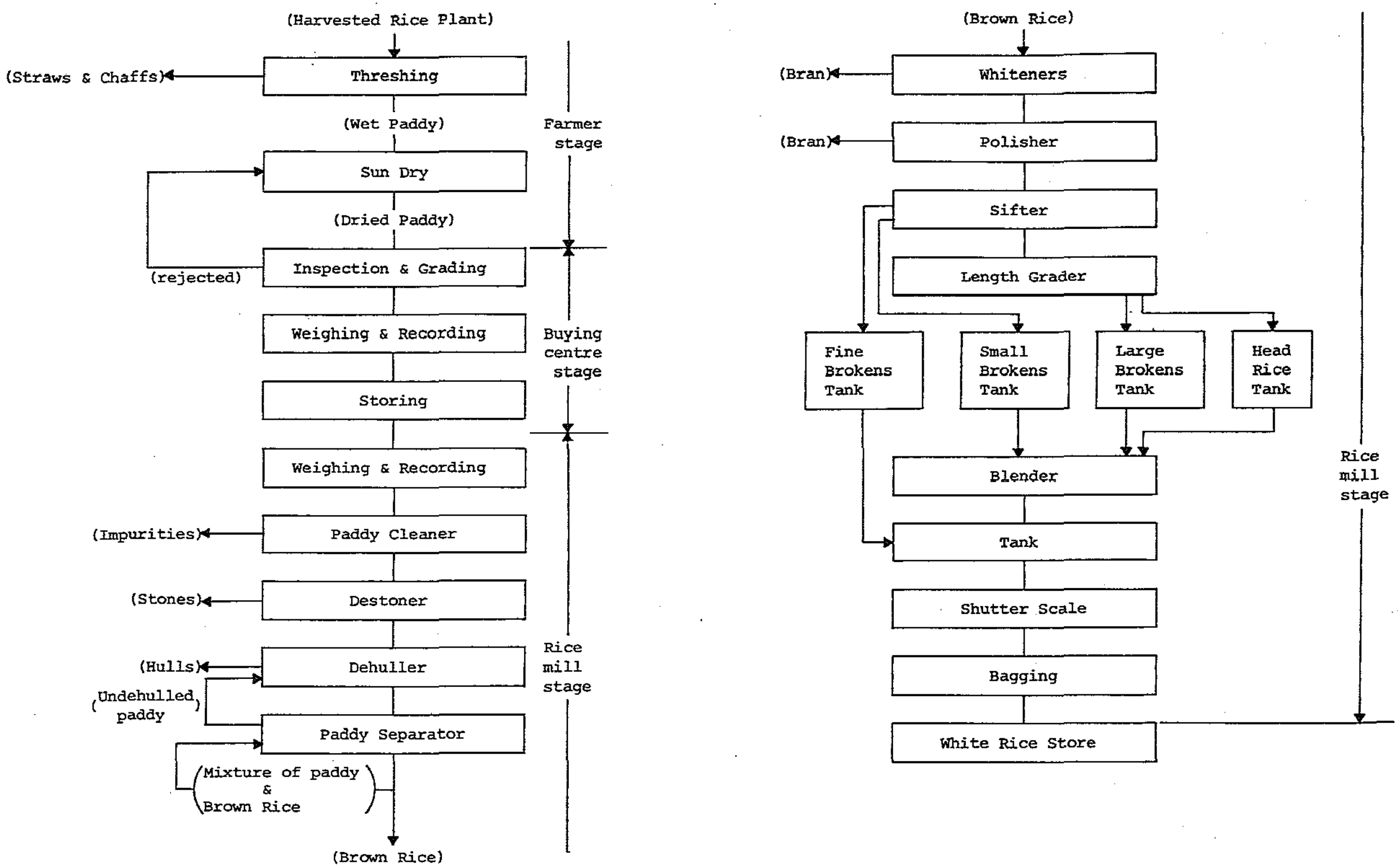
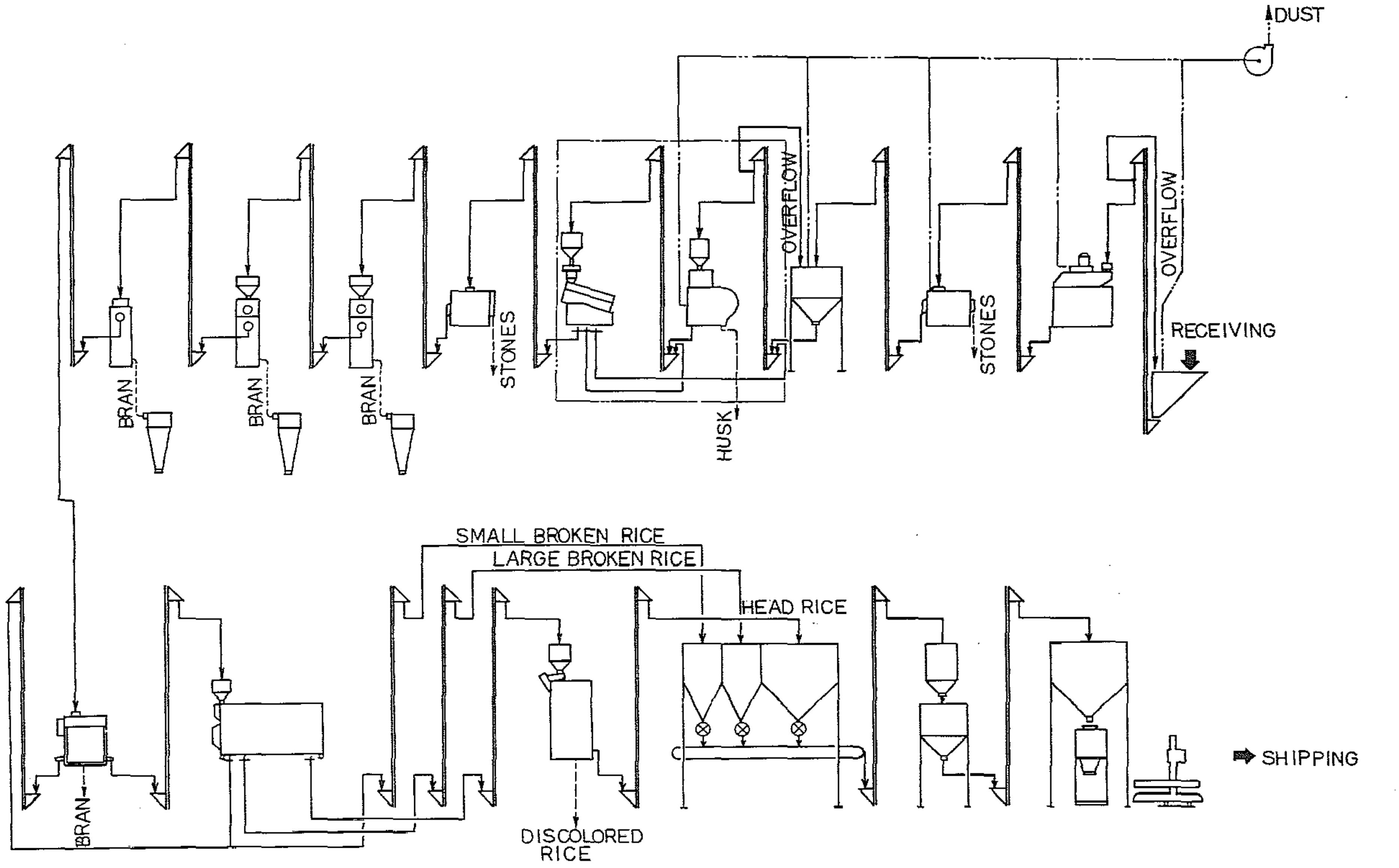


Fig. 5.7 FLOW CHART OF PADDY / RICE IN MILLING STAGE



ANNEX VI

IRRIGATION AND DRAINAGE

ANNEX VI

IRRIGATION AND DRAINAGE

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CHAPTER 1 PRESENT CONDITION OF IRRIGATION AND DRAINAGE SYSTEM

1.1 Irrigation System

In the study area, there are three experimental farms, namely No. 1, No. 2 and No. 3. Out of them, No. 2 experimental farm, which is located at about 1.8 km south from Ngoundoup village on the north-eastern part of the study area, has about 10 ha of paddy fields. During the survey period by the JICA Study Team, about 6 ha was irrigated getting water from a small natural stream. The irrigation system is however very primitive one only provided with small scale earth canals without regulating and control facilities for water management. Except for this experimental farm, there exist no irrigation systems in and around the study area.

SODERIM and UNVDA Projects are major irrigation projects in West and North-West provinces. The outlines of these irrigation systems are described as follows based on the field inspection by the Study Team.

SODERIM (Mbo Plain Rice Development Cooperation) Project area is located at Santchou about 1.8 km north from Melong along the national road linking Douala and Bafoussam. At present, about 230 ha of paddy fields in total are irrigated dividing into several irrigation blocks. Irrigation water for each block is taken from the Nkam river by use of pumps. The irrigation system consists of main, secondary and tertiary irrigation canals, and some structures for distribution of irrigation water and for conveyance of water crossing roads. In the fields, the double cropping of rice per year is practiced with the first cycle from August to January or February and the second cycle from January to May or June.

UNVDA (Upper Noun Valley Development Authority) Project area is situated at Ndop about 30 km east from Bamenda, the capital of North-West province. In this project about 6,700 ha of paddy are envisaged providing with 10 irrigation blocks and at present, about 1,100 ha of paddy fields are irrigated with 2 irrigation blocks. Each irrigation block is protected by dike from entering water into the paddy fields, and has the gravity irrigation system consisting of a weir, intake structure, earth irrigation canals and some structures related to the canals. Only one cropping of rice per year is practiced due to shortage of irrigation water.

1.2 Drainage System

The Baigom plain receives two main rivers, namely Ndoup and Nja. These two rivers join at the lower part of the plain so as to form the Nkoup river. There are also a large number of tiny basins coming from the northern hills or Mbetpit mountain mass on the south. The total area of the external drainage basins is about 62 km^2.

The Ndoup river enters into the plain at the north-eastern corner with the catchment area of 19.8 km^2. In the upper part of the basin, small streams come down from the Nkogam mountain mass with steep slopes and then the river flows down with a gentle slope to the intake weir site for supplying drinking water to the Koundja military camp. After passing the intake weir site, the Ndoup river runs deeper between the gneiss hills and reaches to the Baigom plain crossing the national road. All the catchment area of the Ndoup river has a natural vegetation of more or less arbored savannah.

After entering into the plain, the width of river becomes very narrow and deep, but the shape of river is marked well only at a short distance. Then it penetrates through more or less marshy forest following along the northern edge of the volcanic island located in the center of the plain. However, the shape of river is scarcely marked there developing many small arms. The Ndoup river continues its way in a more marshy prairie zone until it meets the Nja river so as to form the Nkoup river.

The Nja river enters into the plain at the eastern corner having the catchment area of 17.1 km2. It originates in the basaltic plateau with a gentle slope on the north of Koundja. The Koutaba airport and the Koundja military camp are situated in this catchment area. The natural vegetation is constituted of arbored savannah, but on the south-east of the airport, there are some upland fields and coffee plantations. From the plateau, the Nja river flows down with natural falls crossing the ridge of gneiss flanking the plain on the north-east. In this part, the Nja river is bordered by a narrow forest gallery and both sides of the river become very steep.

After entering into the plain, the river runs in a vast marshy forest dividing into multiple arms, and it crosses slowly the narrow passage separating the volcanic island from the Mbetpit mountain mass. It then is named the Nchi and flows in a marshy forest, where the shape of river is scarcely marked. It joins the Nkoup river about 3 km upstream of the Baigom bridge.

Independently of the above two rivers, the plain has many small stream basins from the northern hills and from the Mbetpit mountain mass. In total, these small stream basins are estimated to be about 25 km^2.

The Nkoup river which is named after joining the Ndoup and the Nja rivers, runs in a marshy prairie at the lower part of the plain. It crosses the national road at the Baigom bridge and flows down to the Foumbot city which is situated about 9 km downstream from the Baigom bridge. A intake weir for supplying water to the Foumbot city is constructed on the Nkoup river at the entrance into the city. The existing flow capacity of the Nkoup river is estimated to be more than 30 m^3/sec in most parts but less than 10 m^3/sec in some parts, especially just downstream of the Baigom bridge.

At present, most of the Baigom plain are inundated during the rainy season, for that the following reasons are considered:

(1) existence of the basaltic shelf on the Nkoup river about 400 m upstream from the Baigom bridge, which dams up the river stream,

(2) insufficient flow capacities of the existing rivers, such as Nkoup, Ndoup and Nja, and lack of proper drainage canals other than the above three rivers, and

(3) growing of grasses and forests in the plain which hinders smooth water flow.

CHAPTER II PROJECT FORMULATION

2.1 Available Water Resources

The main water sources in the Baigom plain are the Ndoup and Nja rivers. The Ndoup river enters into the plain at the north-eastern corner with the catchment area of 19.8 km^2, and the Nja river having the catchment area of 17.1 km^2 flows into the plain at the eastern corner.

The base year for irrigation plan was determined based on the drought year with a five-year return period and therefore, the assessment of available irrigation water was made for discharges of the Ndoup and the Nja rivers in the drought year with a five-year recurrence.

The 10-day mean discharges of both rivers in the drought year with a five-year return period were estimated by the simulation method of the hydrological analysis based on the available data on discharges and rainfalls. They are shown below:

(Unit: m^3/sec)

Month	10-day	Ndoup River (C A = 19.8 km^2)	Nja River (C A = 17.1 km^2)	Month	10-day	Ndoup River (C A = 19.8 km^2)	Nja River (C A = 17.1 km^2)
Jan.	1	0.306	0.391	Jul.	1	0.428	0.440
	2	0.277	0.324		2	0.539	0.526
	3	0.274	0.301		3	0.593	0.566
Feb.	1	0.221	0.279	Aug.	1	0.651	0.620
	2	0.190	0.256		2	0.716	0.674
	3	0.166	0.237		3	0.779	0.782
Mar.	1	0.142	0.220	Sep.	1	0.918	0.836
	2	0.130	0.210		2	0.922	0.843
	3	0.121	0.202		3	0.925	0.858
Apr.	1	0.120	0.197	Oct.	1	0.950	0.878
	2	0.123	0.191		2	0.920	0.860
	3	0.127	0.195		3	0.851	0.815
May	1	0.176	0.248	Nov.	1	0.745	0.742
	2	0.250	0.301		2	0.581	0.629
	3	0.245	0.303		3	0.436	0.514
Jun.	1	0.234	0.300	Dec.	1	0.371	0.428
	2	0.269	0.325		2	0.332	0.386
	3	0.318	0.360		3	0.290	0.326

2.2 Water Balance Study

In order to clarify the optimum scale of the irrigation area and storage dams, a water balance study was made on a 10-day basis in the drought year with a five-year return period based on the available discharges of the Ndoup and the Nja rivers, and the irrigation water demands estimated on the proposed cropping pattern.

(1) Irrigable area

Out of the gross area of about 2,800 ha in the study area, the irrigable area was estimated to be 2,000 ha in net area based on the topographic maps with a scale of 1/5,000 taking into account the proposed irrigation canal alignment and topographic condition.

(2) Cropping pattern

The following two cropping patterns were taken into consideratin for the water balance study based on the natural and socio-economic conditions in and around the study area, and the policy of agricultural development programs at the national and regional levels:

i) Paddy : 50%
Upland crops : 50%

(Maize, Groundnuts, Soybean, Tomato)

ii) Paddy : 75%
Upland crops : 25%

(Maize, Groundnuts, Soybean, Tomato)

(3) Irrigation water requirement

Based on the proposed cropping pattern, the irrigation water requirements were estimated on a 10-day basis by using meteorological data around the study area. The effective rainfalls were estimated by the daily water balance method, and the diversion water requirements were obtained as the overall irrigation efficiency of 50%.

(4) Storage dam

Two dam sites were found in the upper reaches of the Ndoup and Nja rivers. They are suitable site from the topographical and geological viewpoints. From the available discharges of the Ndoup and Nja rivers, the maximum scale of the dams on the respective rivers was estimated as follows:

i) Ndoup dam

- Drainage area : 16.7 km^2
- Gross storage capacity : 10,500,000 m^3
- Dead storage capacity : 130,000 m^3
- Dam type : fill dam
- Dam embankment volume 200,000 m^3

ii) Nja dam

- Drainage area : 20.8 km^2
- Gross storage capacity : 12,800,000 m^3
- Dead storage capacity : 160,000 m^3
- Dam type : fill dam
- Dam embankment volume : 800,000 m^3

(5) Alternative plan

In the water balance study, the following five alternative plans were taken into consideration for optimization of the irrigation area:

Case	Crops		Storage Dam
1	Paddy : Upland crops :	50% 50%	None
2	Paddy : Upland crops :	50% 50%	Ndoup & Nja Dams
3	Paddy : Upland crops :	50% 50%	Ndoup Dam only
4	Paddy : Upland crops :	75% 25%	None
5	Paddy : Upland crops :	75% 25%	Ndoup & Nja Dams

(6) Result of water balance study

The water balance study was made for the above five cases and the relation between the irrigation area and the dam scale is summarized as shown below:

Description	Case				
	1	2	3	4	5
1. Irrigation Area					
a) Rainy Season	(ha)	(ha)	(ha)	(ha)	(ha)
- Paddy	1,000	1,000	1,000	1,500	1,500
- Maize	750	750	750	375	375
- Groundnuts	250	250	250	125	125
Sub-total	2,000	2,000	2,000	2,000	2,000
b) Dry Season					
- Paddy	180	1,000	650	210	1,500
- Soybean	45	250	162.5	17.5	125
- Groundnuts	45	250	162.5	17.5	125
- Tomato	90	500	325	35	250
Sub-total	360	2,000	1,300	280	2,000
Total	2,360	4,000	3,300	2,280	4,000
2. Storege Dam					
a) Ndoup Dam		($\times 10^3 m^3$)	($\times 10^3 m^3$)		($\times 10^3 m^3$)
- Gross storage capacity	-	8,760	8,110	-	8,650
- Dam embankment volume	-	181	165	-	173
b) Nja Dam					
- Gross storage capacity	-	4,930	-	-	12,530
- Dam embankment volume	-	246	-	-	800

2.3 Optimum Scale of Development Plan

A comparison of the alternatives was made based on the Internal Rate of Return (IRR) and Benefit-Cost Ratio (B/C) with the following results:

Description	Case				
	1	2	3	4	5
IRR (%)	9.0	12.1	11.8	9.0	8.4
B/C	0.80	1.25	1.22	0.88	0.82

Note: B/C was estimated at a discount rate of 10%

From the above, Case 2 was selected as the best economic alternative with the highest IRR, and in this case, the whole potential area can be irrigated not only in the rainy season but also in the dry season.

Thus, the optimum scale of the Project was determined as follows:

(1) Storage dam

a) Ndoup dam

- Crest elevation : El. 1,175.5 m
- Full water level : El. 1,171.5 m
- Low water level : El. 1,156.0 m
- Gross storage capacity : 8,760,000 m^3
- Active storage capacity : 8,630,000 m^3
- Dam height : 25.5 m
- Dam crest length : 155.0 m
- Dam embankment volume : 180,900 m^3

b) Nja dam

- Crest elevation : El. 1,145.0 m
- Full water level : El. 1,141.0 m
- Low water level : El. 1,127.0 m
- Gross storage capacity : 4,930,000 m^3
- Active storage capacity : 4,770,000 m^3
- Dam height : 26.0 m
- Dam crest length : 260.0 m
- Dam embankment volume : 245,600 m^3

(2) Irrigation Area (average of two year rotation)

(Unit: ha)

Crops	Rainy Season	Dry Season
Paddy	1,000	1,000
Maize	750	-
Groundnuts	250	250
Soybean	-	250
Tomato	-	500
Total	2,000	2,000

CHAPTER 3 DAM AND RESERVOIR PLAN

3.1 Location of Dam Site

Two storage dams would be constructed on the Ndoup and Nja rivers. The proposed Ndoup dam site is located at about 1.6 km upstream from the culvert crossing the national road No. 2. The catchment area at the dam site is 16.7 km^2 with a natural vegetation of more or less arbored savannah. The Nja dam having a catchment area of 20.8 km2 is located at about 1.5 km downstream of the staff gauge installed by SEDA. The Nja river originates in the basaltic plateau with a gentle slope on the north of Koundja. The Koutaba airport and the Koundja military camp are situated in this catchment area.

3.2 Physical Characteristics

In order to obtain the storage volume of the reservoir, the storage capacity and area versus elevation curves were developed by planimetering using the topographic maps with the scales of 1/5,000 and 1/50,000. Fig. 6.1 and Fig. 6.2 show the curves of the Ndoup and Nja reservoirs, respectively.

The dead storage capacity in the reservoir is defined to be equivalent to the sediment volume deposited in the reservoir. The design sediment load was assumed to be about 80 m^3/km^2/year from the geological viewpoint in the watershed of the river. The useful life of reservoir is considered to be 100 years and therefore, the dead storage capacities in the Ndoup and Nja reservoirs were estimated as follows:

Ndoup Reservoir:

$$Qs = 80\ m^3/km^2/year \times 16.7\ km^2 \times 100\ years = 130{,}000\ m^3$$

Nja Reservoir:

$$Qs = 80\ m^3/km^2/year \times 20.8\ km^2 \times 100\ years = 160{,}000\ m^3$$

On the assumption that sediment is deposited level with the bottom of the reservoir, the low water levels were given as El. 1,156.0 m in the Ndoup reservoir and El. 1,127.0 m in the Nja reservoir.

The optimum scale of the reservoir was analysed based on the water balance study and the required active storage capacities were determined to be 8.63 MCM for the Ndoup reservoir and 4.77 MCM for the Nja reservoir. For the above, the gross storage capacities and full water levels were calculated as shown below:

Ndoup Reservoir : Qg = 8.63 + 0.13 = 8.76 MCM
F.W.L. 1,171.5 m

Nja Reservoir : Qg = 4.77 + 0.16 = 4.93 MCM
F.W.L. 1,141.0 m

3.3 Dam Engineering

The proposed dam sites are composed of lateritic soils formed by weathering of schists. Considering the proposed dam scale, availability of embankment materials nearby the dam site, geological and topographic conditions at the site, etc., the homogeneous type fill dam was selected as the most optimum dam type. The typical cross sections of the Ndoup and Nja dams are shown in Figs. 6.3 and 6.4. As shown in these figures, the dam body would consist of three zones: Zone 1 - impervious zone, Zone 2 - semi-pervious zone and Zone 3 - intercepter drain and horizontal drain. The embankment materials for Zone 1 and 2 would be obtained nearby the dam site including the excavated materials of appurtenant structures such as spillway, diversion structure, etc. The drain materials should be purchased since they can not be found around the dam site. The riprap would be provided for protection of the upstream slope using the excavated rocks at the downstream of the Nkoup river.

The elevation of dam crest was determined as shown below taking into account the overflow depth at the spillway and the freeboard.

Ndoup Dam : F.W.L 1,171.5 m + 1.5 m + 2.5 m = El. 1,175.5 m

Nja Dam : F.W.L 1,141.0 m + 1.5 m + 2.5 m = El. 1,145.0 m

The width of dam crest was designed to be 8.0 m from the viewpoint of the practicability of construction. Stability of the dam against sliding was analysed by means of sliced slip circle method. A safety factor obtained by this method is derived by the following formula:

$$Fs = \frac{\Sigma\{C \cdot \ell + N \cdot \tan\phi\}}{\Sigma T}$$

where, Fs: Safety factor

N: Normal effective force acting on sliced slip circle

T: Tangential effective force acting on sliced slip circle

C: Cohesion of materials

ϕ: Angle of internal friction of materials

ℓ: Arc length of sliced slip circle

The safety factor of critical slip circle was set at 1.20 as the minimum allowable safety factor. From the results of stability analysis, the embankment slopes of upstream and downstream were determined to be 1: 2.5 - 2.9 and 1: 2.3 - 2.5, respectively.

3.4 Appurtenant Structures

(1) Diversion structure

The peak discharge of the diversion design flood was obtained at 10-year flood as follows:

Ndoup Dam : $Qd = 12.3\ m^3/sec$

Nja Dam : $Qd = 9.4\ m^3/sec$

The concrete box was applied as the diversion structure and the section of the box was designed to be 2.0 m in height and 2.0 m in width.

(2) Spillway

The spillway was designed for the design flood discharge which was based on the 1.2 times of 200-year flood.

Ndoup Dam : $Qs = 95.0\ m^3/sec$

Nja Dam : $Qs = 115.0\ m^3/sec$

The spillway would be composed of side channel weir, transition, chute and energy dissipator. The ungated side channel type was selected to avoid the troubles for the gate operation. The optimum overflow depth of the weir was determined to be 1.5 m considering the relationship between the crest length of side channel and dam height.

(3) Outlet

Outlet works comprise intake structure and outlet conduit. The intake structure was designed to be drop inlet type for the following intake discharges:

Ndoup Dam : $Q = 1.261\ m^3/sec$

Nja Dam : $Q = 1.157\ m^3/sec$

Water taken at the intake would drive through the diversion concrete box up to the point of plug concrete and then flow through outlet conduit as pressure pipe flow with the steel pipe having diameter of 0.8 m provided in the diversion concrete box. The hydraulic energy of water would be dissipated at the downstream of outlet conduit by using the jet flow gate with the discharge control.

3.5 Work Quantities

On the basis of the preliminary design aforementioned, the drawings of the dam and appurtenant structures were prepared as attached in ANNEX XII. The work quantities were estimated as shown below based on the drawings:

Work Item	Ndoup Dam	Nja Dam
(1) Dam		
(a) Excavation	68,800 m^3	63,700 m^3
(b) Embankment		
- Zone 1	45,300 m^3	46,300 m^3
- Zone 2	123,500 m^3	178,600 m^3
- Drain	8,300 m^3	16,000 m^3
- Riprap	3,800 m^3	4,700 m^3
(2) Spillway		
(a) Excavation	36,900 m^3	63,800 m^3
(b) Back filling	6,700 m^3	9,700 m^3
(c) Concrete	3,760 m^3	5,030 m^3
(d) Reinforcement bar	132.4 ton	176.4 ton
(e) Concrete form	4,700 m^2	5,920 m2
(3) Diversion Structure		
(a) Excavation	2,800 m^3	2,800 m^3
(b) Concrete	1,720 m^3	1,720 m^3
(c) Reinforcement bar	77.4 ton	77.4 ton
(d) Concrete form	1,180 m^2	1,180 m^2
(4) Outlet Works		
(a) Concrete	140 m^3	140 m^3
(b) Reinforcement bar	6.4 ton	6.4 ton
(c) Concrete form	400 m^2	400 m^2
(d) Steel pipe ø800 mm	131.1 m	131.1 m
(e) Regulating valve	1 no.	1 no.

CHAPTER 4 IRRIGATION DEVELOPMENT PLAN

4.1 Irrigation Water Requirement

Rice is the principal crop to be cultivated in the project area and upland crops such as maize, groundnuts, soybean and tomato are also recommended as consumable and profitable crops for the Project. The study of irrigation water requirements was made for these crops.

The irrigation water requirements were calculated for the proposed cropping pattern on 10-day basis for the drought year with five-year return period.

4.1.1 Irrigation water requirement for paddy

(1) Crop water requirement

The crop water requirement is defined as the amount of water needed to meet the consumptive demand of the crop for optimum growth from seeding to harvesting. It consists of puddling, nursery and field crop requirements as shown below:

$$CWR = Pu + Nu + Fc$$

where, CWR: Crop water requirement (mm/day)
Pu: Puddling requirement (mm/day)
Nu: Nursery requirement (mm/day)
Fc: Field crop requirement (mm/day)

1) Puddling requirement

The puddling requirement is the amount of water needed to saturate the soil and break its upper layer for transplanting.

$$Pu(i) = \frac{Sn + Sp}{N} + \frac{i - 1}{N} \cdot (Ev + P)$$

$$Sn = Ds \cdot (Sc - Mc)$$

where, Pu(i): Puddling requirement (mm/day)
i: Day number (i = 1- N)
Sn: Soil saturation requirement (60 mm)
Sp: Depth of ponding for transplanting (20 mm)
N: Number of days for puddling (2 days)
Ev: Evaporation (mm/day)
P: Percolation rate (3 mm/day)
Ds: Depth of soil saturation (300 mm)
Sc: Soil saturation capacity (% in volume)
Mc: Soil moisture content (% in volume)
Mc = ME (Moisture Equivalent, pF 3.0)
= Moisture content of depletion for optimum growth

In the above equation, the rates of Sc and Mc were determined as below, taking into account the soil texture in the project area.

Soil Texture	Sc (%)	Mc (%)
Clay loam	55	35

The percolation rate was determined taking into account the field condition after the implementation, on the basis of actual measurement carried out by the Study Team during the field survey period. The results of field tests are shown in Table 6.1. The locations of the tests were three points in the experimental farm No. 2 as shown in Fig. 6.5. Considering the topography and soil texture in the experimental farm, the applicable percolation rate to the whole field be lower than the test results. The percolation rate adopted in the study was determined 3 mm/day.

2) Nursery requirement

The nursery requirement is the amount of water needed for nursery preparation and growth of seedling until its transplanting to main field:

$$Nu(i) = Knu \cdot (Sn + Kc \cdot ETo + P) \cdot 1.5 \qquad (i = 1)$$

$$Nu(i) = Knu \cdot (Kc + ETo + P) \cdot 1.5 \qquad (i = 2 - 20)$$

where, Nu(i): Nursery requirement

i: Day number (i = 1 - 20)

Knu: Ratio of nursery area to main field (0.05)

Sn: Soil saturation requirement (60 mm)

Kc: Crop coefficient of seedling

ETo: Potential evapotranspiration (mm/day)

P: Percolation rate (3 mm/day)

1.5: Coefficient for increase of border seepage loss ratio

3) Field crop requirement

The field crop requirement is amount of water consumed by the crop during the period from transplanting to 15 days before harvesting and the needed percolation in the paddy field.

$$Fc = Kc \cdot ETo + P$$

where, Fc: Field crop requirement (mm/day)

Kc: Crop coefficient

ETo: Potential evapotranspiration (mm/day)

P: Percolation rate (3 mm/day)

The crop coefficients to crop growth stages were estimated based on the method of FAO Irrigation and Drainage Paper 24 revised 1977 "Crop Water Requirements". The crop coefficients in rainy and dry seasons are shown in Table 6.2 and Fig. 6.6.

The potential evapotranspiration was calculated by the Pan Evaporation Method using meteorological data at the Koundja station. The results are shown in Table 6.3 and Fig. 6.7.

(2) Farm water requirement

The farm water requirement is assessed on 10-day basis as below:

$$FWR = AF \cdot \sum_{i=1}^{e} \{CWR(i) - RE(i)\}$$

where, FWR: Farm water requirement (mm/10-day)

AF: Area factor

i: Day number in 10-day

e: Last day number in 10-day

CWR(i): Crop water requirement (mm/day)

RE(i): Effective rainfall (mm/day)

The effective rainfall was estimated by the daily water depth balance method as described below.

Rainfall adapted to the effective rainfall culculation were determined as follows:

$$R < Rmin : RA = 0$$

$$Rmin \leqq R \leqq Rmax : RA = R$$

$$Rmax < R : RA = Rmax$$

where, R: Rainfall (mm/day)

Rmin: Minimum adaptable rainfall (5 mm/day)

Rmax: Maximum adaptable rainfall (50 mm/day)

RA: Rainfall height adaptable to calculation (mm/day)

The daily water depth balance calculation was made assuming two kinds of crest heights of outlet from a farm plot respectively in growing stage requiring shallow ponding depth and stage requiring deep.

$$PWL(i) = PWL(i-1) - CWR(i) + RA(i)$$

where, PWL(i): Water level in the paddy field (mm)

i: Day considered

CWR(i): Crop water requirement (mm)

RA(i): Rainfall height adaptable to calculation (mm)

Using the above equation, an overflow occurs when the computed PWL exceeds the crest height of outlet. The amount of effective rainfall was then determined as follows:

Without overflow RE = RA

With overflow RE = PSH - PWL + CWR

where, RE: Effective rainfall (mm/day)

PSH: Crest height of outlet from farm plot (mm)

The crest height of outlet was determined as follows:

(Unit: mm)

Growing Stage	Optimum Ponding Depth	Crest Height of Outlet
Shallow ponding	30	110
Deep ponding	70	150

In calculating the effective rainfall, the daily rainfall data in the drought year with five-year return period were used, which were estimated as shown in Table 1.7 of ANNEX-I.

The calculated results of the farm water requirement and effective rainfall are shown in Tables 6.4 and 6.5.

(3) Diversion water requirement

The diversion water requirement is defined as the farm water requirement plus allowances for farm waste, operation losses and conveyance losses.

DWR = FWR/Ef

where, DWR: Diversion water requirement (mm/10-day)

FWR: Farm water requirement (mm/10-day)

Ef: Overall irrigation efficiency

The overall irrigation efficiency was estimated as follows:

(Unit: %)

Item	Efficiency
On-farm efficiency	75
Conveyance efficiency	80
Operation efficiency	85
Overall efficiency	50

The calculated results of diversion water requirements are shown in Table 6.6.

4.1.2 Irrigation water requirement for upland crops

(1) Crop water requirement

The crop water requirement consists of land preparation requirement and consumptive use of the crops.

$$CWR = Lp + Fc$$

where, CWR: Crop water requirement (mm/day)

Lp: Land preparation requirement (mm/day)

Fc: Field crop requirement (mm/day)

Only tomato is seeded on nursery bed and transplanted after 45 days of seeding to the main field. However, the nursery requirement was neglected in calculating the crop water requirement of tomato.

1) Land preparation requirement

The land preparation requirement is the amount of water needed to prepare satisfactory field condition for seeding and transplanting.

$$Lp = Pr/N$$

where, Lp: Land preparation requirement (mm/day)

Pr: Pre-irrigation for land preparation (50 mm)

N: Number of days for land preparation (3 days)

2) Field crop requirement

The field crop requirement is amount of water consumed by the crops during the period from seeding to 5 days before harvesting of maize, groundnut, soybean and the peirod from transplanting of tomato.

$$FC = Kc \cdot ETo$$

where, FC: Field crop requirement (mm/day)

Kc: Crop coefficient

ETo: Potential evapotranspiration (mm/day)

The crop coefficients crop growth stages were estimated based on the method of FAO Irrigation and Drainage Paper 24 revised 1977 "Crop Water Requirements". The crop coefficients of those upland crops in rainy and dry seasons are shown in Table 6.2 in Fig. 6.6, respectively.

The potential evapotranspiration is shown in Table 6.3 and Fig. 6.7, as described in the previous paragraph.

(2) Farm water requirement

The farm water requirement can be obtained by subtracting the effective rainfall from the crop water requirement as shown below.

$$FWR = AF \cdot \sum_{i=1}^{e} \{CWR(i) - RE(i)\}$$

where, FWR: Farm water requirement (mm/10-day)

AF: Area factor

i: Day number in 10-day

e: Last day number in 10-day

CWR(i): Crop water requirement (mm/day)

RE(i): Effective rainfall (mm/day)

The effective rainfall was estimated by the daily moisture level balance method as described below.

Rainfall adapted to the effective rainfall calculation were determined as follows:

$$R < Rmin : RA = 0$$

$$Rmin \leqq R \leqq Rmax : RA = R$$

$$Rmax < R : RA = Rmax$$

where, R: Rainfall (mm/day)

Rmin: Minimum adaptable rainfall (5 mm/day)

Rmax: Maximum adaptable rainfall (50 mm/day)

RA: Rainfall height adaptable to calculation (mm/day)

The daily moisture level balance calculation was made assuming the water holding capacity after 24 hours of soil saturation in the root zone. The water holding capacities of upland crops in rainy and dry seasons were estimated based on the method of FAO "Crop Water Requirements" according to the soil texture of field in the project area.

The soil texture is as follows:

Soil Texture	Sc (%)	M_{24} (%)	ME (%)
Clay loam	55	50	35

where, Sc: Saturation capacity (% in volume)

M_{24}: Water holding capacity after 24 hours of soil saturation (% in volume)

ME: Moisture equivalent, pF 3.0, or moisture content of depletion for optimum growth (% in volume)

The calculation of the water holding capacity for each crop is shown in Table 6.7. The water holding capacity in the root zone of each crop was obtained as follows:

Crop	Season	MH_{24} (mm)
Maize	Rainy season	293
Groundnuts	Rainy season	130
	Dry season	132
Soybean	Dry season	200
Tomato	Dry season	180

The daily moisture level in the root zone is calculated by the following equation.

$$ML(i) = ML(i-1) - CWR(i) + RA(i)$$

where, ML(i): Moisture level in root zone (mm)

i: Day considered

CWR(i): Crop water requirement (mm)

RA(i): Rainfall height adaptable to calculation (mm)

Using the above equation, the effective rainfall was determined as follows:

In case of $ML(i) \leqq MH_{24}$ $\quad RE = RA$

In case of $MH_{24} < ML(i)$ $\quad RE = MH_{24} - ML(i-1) + CWR$

where, Re: Effective rainfall (mm/day)

MH24: Water holding capacity after 24 hours of soil saturation (mm)

The calculated results of the farm water requirement and effective rainfall are shown in Table 6.8 and Table 6.9, respectively.

(3) Diversion water requirement

The diversion water requirement was calculated from the farm water requirement with assumed overall irrigation efficiency of 50%.

The calculated results of diversion water requirements are shown in Table 6.10.

4.1.3 Diversion water requirement for proposed cropping pattern

The diversion water requirement in each 10-day period for the proposed cropping pattern is shown in Table 6.11.

4.2 Proposed Irrigation System

4.2.1 Basic consideration

Since there are no existing irrigation facilities in the project area, the proper irrigation system should be newly established. Based on the result of study on the optimum scale of the development plan, the following irrigation works were proposed:

1) Construction of two storage dams, i.e. Ndoup and Nja dams,
2) Construction of a intake weir on the Ndoup river, and
3) Establishment of irrigation canal network such as main and secondary irrigation canals, and related structures.

The total irrigation area of 2,000 ha in net is divided into two irrigation systems as shown below according to the topographic condition and available irrigation water supplied by two storage dams.

Ndoup irrigation system : 1,110 ha

Nja irrigation system : 890 ha

4.2.2 Diversion method of irrigation water

The diversion methods of irrigation water in the Ndoup and Nja irrigation systems are mentioned below:

(1) Ndoup irrigation system

The water stored in the reservoir would be released to the Ndoup river and be taken at the Ndoup intake water which would be constructed at about 250 m downstream from the National Road No. 2. The irrigation water would be diverted from the intake weir to the field through the irrigation canals.

(2) Nja irrigation system

The irrigation water would be taken directly from the Nja reservoir without release to the downstream of the river and transported to the field by the irrigation canals.

4.2.3 Irrigation system

The proposed irrigation system is divided into two irrigation systems of the Ndoup and Nja. The Ndoup irrigation system consists of 10 tertiary blocks, and the Nja system of 7 blocks. The total number of tertiary irrigation blocks were determined to be 17 blocks, which average area in net be about 120 ha per block.

The general layout of the proposed irrigation system is shown in Fig. 6.8 and the irrigation diagram is illustrated in Fig. 6.9.

(1) Ndoup irrigation system

The Ndoup irrigation system would be separated into two areas by the Ndoup main drainage canal. Seven tertiary blocks from BD-1 to BD-7 covering 795 ha in net are almost situated in the right side of the Ndoup main drainage canal. Only a part covering 31 ha in net of block BD-1 is in the left side of the canal. The other three tertiary blocks from BD-8 to BD-10 covering 315 ha are located in the area surrounding the volcanic island. The irrigation water to these blocks would be conveyed by a secondary irrigation canal crossing over the Ndoup main drainage canal.

(2) Nja irrigation system

The Nja irrigation system would be separated into two areas by the Nja main drainage canal. Two tertiary blocks of BJ-1 and BJ-2 covering 335 ha in net are situated in the right side of upper stream reach of the Nja main drainage canal. The other five tertiary blocks from BJ-3 to BJ-7 are located in the left side of the canal.

CHAPTER 5 DRAINAGE DEVELOPMENT PLAN

5.1 Drainage Water Requirement

The drainage water requirements for the proposed drainage system were estimated for transporting the runoff from the external drainage basin of the Baigom plain and for removing excess rainfall in the plain on the basis of the design daily rainfall with five-year return period of 73 mm/day.

5.1.1 Runoff from external drainage area

The external drainage basins are broadly divided into three basins, namely Ndoup basin, Nja basin and the other small basins, and the runoff from each basin was estimated by the simulation method of the hydrological analysis using available records of rainfall and discharge.

(1) Ndoup basin

The runoff of Ndoup river at the entrance to the project area, which catchment area is 20.2 km^2, was estimated at 15.0 m^3/sec by conversion of the runoff 14.6 m^3/sec at the Ndoup No. 2 gauging station, which catchment area is 19.8 km^2, using the ratio of these catchment areas.

(2) Nja basin

The runoff of Nja river at the entrance to the project area, which catchment area is 22.2 km^2, was estimated at 10.0 m^3/sec by conversion of the runoff 7.7 m^3/sec at the Nja gauging station, which catchment area is 17.1 km^2, using the ratio of these catchment areas.

(3) Other small basins

The runoff from other small basins were estimated with the average specific runoff 0.60 $m^3/sec/km^2$ of the Ndoup and Nja river basins. The catchment area and runoff of each small basin are shown in the drainage diagram, Fig. 6.10.

5.1.2 Drainage water requirement for paddy field

After implementation of the Project, the Baigom plain would be developed as the agricultural lands consisting of paddy fields and upland fields. The drainage water requirement in the paddy field was calculated using the following formula:

$$Q = \frac{R_{24} \cdot 10^{-3} \cdot A \cdot 10^4}{T \cdot 60 \cdot 60}$$

where,
- Q: Drainage water requirement in the paddy field (m^3/sec)
- R_{24}: Design daily rainfall (73 mm/day)
- T: Drainage period (48 hours)
- A: Drainage area (ha in gross)

The unit drainage requirement in the paddy field area was assessed at 4.22 ℓ/sec/ha on the condition of two days drainage of design daily rainfall 73 mm/day.

5.1.3 Drainage water requirement for upland field

The drainage water requirement in the upland field was calculated by McMath's formula as follows:

$$Q = 9.15 \cdot 10^{-3} \cdot C \cdot i \cdot S^{1/5} \cdot A^{4/5}$$

where, Q: Drainage water requirement in the upland field (m^3/sec)

C: Runoff coefficient (0.30)

i: Rainfall intensity (mm/hour)

$$i = \frac{R24}{24} \cdot \left(\frac{24}{T}\right)^{2/3}, \quad T = 1$$

S: Average slope (1/1,000)

A: Drainage area (ha in gross)

The unit drainage requirement in the upland field area was assessed at 4.38 ℓ/sec/ha, applying above coefficients which were determined in accordance with the upland field conditions after implementation of the Project.

5.1.4 Design drainage water requirement

According to the proposed cropping pattern, the area ratio of paddy field and upland field would be 50% each in a unit holding area per household. The unit drainage water requirement for the farming land was, therefore, determined as an average 4.3 ℓ/sec/ha of the paddy field's requirement and the upland field's one.

The design drainage water requirement at each section of the drainage system was calculated by using the following equations:

Nkoup main drainage canal:

$$Q = Qd + Qj + Qs + Qf$$

Ndoup main drainage canal:

$$Q = Qd + Qs + Qf$$

Nja main drainage canal:

$$Q = Qj + Qs + Qf$$

Secondary drainage canals:

$$Q = Qs + Qf$$

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

Qd: Runoff from Ndoup basin (15.0 m^3/sec)

Qj: Runoff from Nja basin (10.0 m^3/sec)

Qs: Runoff from small basins

$Qs = Cs \cdot As$

C; Specific runoff (0.60 m^3/sec/km2)
As; Basins area (km2)

Qf: Drainage requirement for the farming land (m^3/sec)

$Qf = q \cdot Af$

q; Unit drainage requirement for farming land (4.3 ℓ/sec/ha)
Af; Area of farming land (ha in gross)

5.2 Proposed Drainage System

5.2.1 Basic consideration

For establishment of the proper drainage system in the project area, the following works were proposed:

1) Excavation of the basaltic shelf at the downstream of the Nkoup river,
2) Improvement of the existing three major rivers, namely Nkoup, Ndoup and Nja rivers,
3) Establishment of drainage canal network such as secondary drainage canals, catch drains and their related structures,
4) Construction of the diversion flood way at the south-eastern corner of the project area, and
5) Installation of the regulating gates at the outlet of the Nkoup river.

5.2.2 Flood regulating method

(1) Diversion flood way

The diversion flood way would be constructed at the narrow ridge on the south-eastern corner of the project area to divert the flood discharge from the Nja main drainage canal to another basin. The proposed diversion discharge was estimated to be about 5.8 m^3/sec which was equivalent to half of the design drainage discharge of the Nja main canal. The flood way would consist of the side spillway on the Nja main drainage canal, the cross drain under the Nja irrigation canal and the diversion canal of 700 m in total length. This diversion flood way would be useful in reducing the flood discharge for the downstream of the Nkoup river.

(2) Regulating gates

The existing flow capacities of the downstream of the Nkoup river are not sufficient for the design drainage discharge in some parts, about 2.0 km between just downstream of the Baigom bridge and the confluence with the Chanke river. Therefore, some river improvement works may be required if the design drainage discharge flows down directly without regulation from the project area. In order to mitigate the flood damage for the downstream parts of the Nkoup river, the regulating gates would be installed at the outlet of Baigom plain, just downstream of the Baigom bridge.

5.2.3 Drainage system

The proposed drainage system is divided into three systems, namely the Nkoup, Ndoup and Nja systems. The Nkoup drainage system consists of 24 drainage blocks, in addition to the Ndoup and Nja drainage systems which connect with the upstream end of the Nkoup system. The Ndoup drainage system consists of 12 drainage blocks besides the Ndoup river basin. The Nja drainage system consists of 27 drainage blocks besides the Nja river basin. The total number in these three drainage systems are 63 blocks of small external basins and field drainage blocks besides two major external basins of the Ndoup and Nja rivers. The area per field drainage block was basically determined to be about 60 ha in gross.

The drainage diagram is illustrated in Fig. 6.10 and the general layout of the general layout of the proposed drainage system is shown in Fig. 6.8.

(1) Nkoup drainage system

The Nkoup drainage system consists of the Nkoup main drainage canal and two secondary drainage canals of KSDC-1 covering about 700 ha in gross and KSDC-2 covering about 730 ha. The catchment area of the system is composed of 10 small external basins and 14 field drainage blocks.

(2) Ndoup drainage system

The Ndoup main drainage canal collects all the drainage water in the system directly from tertiary drainage canals. The catchment area of the system is composed of 5 small external basins including a basin in the volcanic island and 7 field drainage blocks.

(3) Nja drainage system

The Nja drainage system would have the diversion flood way, which would divert a half of the design discharge at about 4,660 m upstream from a junction with the Nkoup main drainage canal. The catchment area of the system is composed of 7 small external basins including two basins in the volcanic island and 20 field drainage blocks. Further, there is one small external basin which belongs to the diversion flood way.

In the Nja drainage system, there exists the deep histic layer which area is estimated at about 300 ha. To promote the utilization of land for agriculture, twice of the density of drain inlet to the Nja main drainage canal was adapted. The area per field drainage block in this area is about 30 ha in gross.

CHAPTER 6 FARM ROAD DEVELOPMENT PLAN

6.1 Basic Consideration

For operation and maintenance of the project facilities and effective agricultural activities after implementation of the Project, establishment of the proper farm road network is of vital importance. The proposed road network consist of main farm roads and inspection roads. The main farm roads would be provided to link the project area and the national road No. 2, and between the inspection roads in the project area. The inspection roads would be constructed along main and secondary irrigation and drainage canals for inspection, operation and maintenance of canals. These roads would also be used for the purpose of farm operation.

The total lengths of the above roads were estimated as follows:

Name of Road	Total Length (m)
1. Main farm roads	13,570
2. Inspection roads for main and secondary irrigation canals	26,200
3. Inspection roads for main and secondary drainage canals	19,955
Total	59,725

The effective width of each road was designed to be 4.0 m with the gravel pavement for the proper operation and maintenance of the project facilities and for the smooth agricultural activities.

6.2 Proposed Farm Road System

6.2.1 Main farm road

To link the project area and the national road No. 2, and between the inspection roads in the project area, 8 routes of the main farm road are proposed.

The main farm road MFR-6 would enter the project area around center point of the northern boundary and connect to the end of the Ndoup main irrigation canal.

The route of MFR-5 is the existing one entering the present experimental farm Zone-I. This would link between the national road No. 2 and the lower reach of the Ndoup secondary irrigation canal DSIC-1.

6.2.2 Canal inspection road

The canal inspection roads would be constructed along main and secondary irrigation and drainage canals.

(1) Inspection road for irrigation canal

Inspection roads along the irrigation canals which are aligned on the boundary of the project area would be constructed in the field side of canals for easy access to the farm land.

(2) Inspection road for drainage canal

Inspection roads along the drainage canals would be constructed in the left side of canals, considering the access from farm lands.

CHAPTER 7 ON-FARM DEVELOPMENT PLAN

7.1 Basic Consideration

The gross area of the Baigom plain in 2,800 ha comprising 1,200 ha of forests, 1,110 ha of grasslands, 460 ha of upland fields and 30 ha of others. For introduction of the modernized farming method in the plain, most areas should be reclaimed with the proper irrigation and drainage facilities.

The average slope of the area is about 1/1,000 with the elevation of 1,118 m to 1,125 m. The soil depth to be useful for plowing layer was estimated at about 30 cm based on the soil survey. The typical size of a farm plot was determined to be 0.3 ha (100 m x 30 m) taking into consideration the above topography, soil condition and efficient farming practices. The farm plot would be generally reclaimed in parallel to the contour line and to be of rectangular shape in order to minimize the earth moving volumes and the cutting depth as small as possible.

The net irrigation area of 2,000 ha would be divided into 17 tertiary irrigation blocks in consideration of the topographic condition, canal alignment, water management, etc. Each tertiary block would be served with irrigation water by one turnout.

7.2 Proposed On-Farm Development Plan

7.2.1 Typical farm layout

In the development plan of main irrigation system, 17 tertiary blocks were formulated, which net average area per block is about 120 ha.

On the other hand, a typical farm layout was established, taking into account the efficient water management and farm operation. Based on the typical layout, the net-gross ratio of area was estimated at 90%.

Considering average size and shape of all the tertiary blocks, the typical block would be of rectangular with 2,050 m x 650 m. The gross area of the typical tertiary block is therefore to be 133 ha, which corresponds with the net farming area of 120 ha, using the above ratio.

The typical farm layout is shown in Fig. 6.11.

7.2.2 On-farm irrigation system

A tertiary irrigation block is composed of several quaternary blocks. A quaternary irrigation block is commanded by a division box on a tertiary irrigation canal. The net area of a quaternary irrigation block was determined at 24 ha as shown in Fig. 6.11. On the typical tertiary irrigation block, there would be five quaternary blocks.

A quaternary irrigation block is composed of four field lots. A field lot is commanded by a quaternary outlet on a quaternary irrigation canal. The net area of a field lot was determined at 6 ha.

A field lot is composed of four farm lots. A farm lot is commanded by a farm outlet or a main farm ditch. The net area of a farm lot was determined at 1.5 ha.

A farm lot is composed of five farm plots. The irrigation water is supplied to the farm plot by the plot-to-plot irrigation method. The net area of a farm plot was determined to be 0.3 ha (100 m x 30 m) as mentioned in the previous section.

Especially for the sloped land of about 300 ha in net which would be reclaimed along the surrounding hilly area, the size of a farm plot was determined to be 0.2 ha (100 m x 20 m) taking into account the work volume of the land reclamation.

7.2.3 On-farm drainage system

The excess water from the on-farm blocks would be drained to the main and secondary drainage canals through the drain inlets which would be constructed on these drainage canals. One drainage unit with about 60 ha of gross catchment area was considered as a tertiary drainage block. Therefore, two tertiary drainage systems would be established in a tertiary irrigation block.

A tertiary drainage block is composed of two or three quaternary drainage blocks as shown in Fig. 6.11.

The drainage blocks from the quaternary level to the farm plot one are just overlapped with the irrigation blocks. The drainage water from the farm plot would flow down through the main drainage ditch, the quaternary drainage canal and the tertiary drainage canal, and flow into the main or secondary drainage canal.

7.2.4 On-farm road system

For operation and maintenance of the on-farm facilities and effective agricultural activities, the proper on-farm road network would be established.

The on-farm road with 2.0 m effective width is aligned on the boundary between two quaternary irrigation blocks as shown in Fig. 6.11.

CHAPTER 8 PRELIMINARY DESIGN OF IRRIGATION AND DRAINAGE FACILITIES

8.1 Ndoup Intake Weir

8.1.1 Basic design condition

The Ndoup intake weir would be constructed to intake the irrigation water for the Ndoup irrigation system.

The intake water level was determined based on the field surface elevation after the project implementation. The design intake discharge is as shown in the irrigation diagram (Fig. 6.9).

8.1.2 Design of intake weir

(1) Weir

Type	:	Fixed type concrete weir
Crest elevation	:	El. 1,125.00 m
Crest length	:	13.0 m in effective
Crest width	:	0.5 m
Weir height	:	1.0 m
Side slope	:	Upstream side ; vertical Downstream side ; 1 : 1.0

The crest length was determined for the design flood discharge 15.0 m^3/sec using the following formula for the submerged overflow condition.

$$Q = \mu' \cdot B \cdot h_2 \cdot \sqrt{2 \cdot g \cdot (h_1 - h_2)}$$

where,
- Q: Discharge (m^3/sec)
- μ': Coefficient for submerged overflow
- B: Crest length (m)
- h_1: Upstream water depth above weir crest
- h_2: Downstream water depth above weir crest
- g: Acceleration of gravity (9.8 m/sec^2)

(2) Scouring sluice

The scouring sluice would be provided at the right side of the river, where the intake structure would be constructed.

Width of sluice section : 1.0 m

Scouring sluice gate : Width 1.0 m x height 1.5 m
1 no.

(3) Intake structure

Slide gate : Width 1.0 m x height 1.0 m
2 nos.

(3) Measuring device

The discharge measurement for intake water would be made with the rectangular weir to be installed at the end of flume section. The overflow depth would be measured under the complete overflow condition.

8.2 Irrigation Canals and Related Structures

8.2.1 Design of irrigation canals

All irrigation canals were designed as unlined canals with trapezoidal sections. The design of the irrigation canals were made based on the basic design criteria described as follows:

(1) Design discharge

Based on the irrigation water requirement calculated in Section 4.1 and the commanding area, the design discharges for irrigation canals were estimated. Irrigation diagram for the proposed irrigation system is shown in Fig. 6.8.

(2) Design water level

The design water level in the irrigation canal was determined based on the required water level at the turnout diverting water to the tertiary irrigation block.

The required water level in the canal at the turnout was estimated at 0.50 m higher than the field surface elevation taking into account head losses caused at several diversion structures and in canals through which the irrigation water would be transferred to each farm plot.

(3) Velocity

The maximum permissible velocity of the unlined canal was determined so as not to cause scouring of canal. The minimum permissible was determined so as not to induce the growth of aquatic plant and moss, and not to cause the sedimentation in canal. Permissible velocity of each canal was determined as follows:

Maximum velocity : 0.8 m/sec

Minimum velocity : 0.3 m/sec

(4) Roughness coefficient

The roughness coefficient of irrigation canals was determined as below, considering the soil texture of canal construction material and the canal inside condition with proper maintenance after the project implementation.

Roughness coefficient : $n = 0.025$

(5) Freeboard

The freeboard of the canal was designed based on the following criteria:

$$Fb \geqq Fbmin$$

$$Fbmin = 0.05 \cdot d + hv + 0.10$$

$$hv = \frac{V2}{2 \cdot g}$$

where, Fb: Freeboard (m)

Fbmin: Minimum freeboard (m)

d: Water depth (m)

hv: Velocity head (m)

V: Velocity (m/sec)

g: Acceleration of gravity (9.8 m/sec2)

(6) Canal section

The canal section was designed taking into account the effective water flow and the canal slope stability.

The relationship between the canal base width and maximum water depth was determined so that the ratio of water depth to base width would be nearly one under the condition that the water depth be less than the base width.

The canal inside slope was determined at 1: 1.5 in accordance with the soil mechanical condition of the construction material.

General features of the irrigation canal are as follows:

Name of Canal	Canal Length (m)	Design Discharge (m^3/sec)	Canal Base Width (m)	Water Depth (m)	Canal Height (m)
DMIC	3,650	1.26 - 0.41	1.00 - 0.80	0.98 - 0.72	1.20 - 0.90
DSIC-1	5,900	0.40 - 0.09	0.80 - 0.40	0.71 - 0.32	0.90 - 0.50
DSIC-2	1,950	0.41 - 0.18	0.80 - 0.50	0.72 - 0.49	0.90 - 0.70
JMIC	4,420	1.16 - 0.36	0.90 - 0.70	0.85 - 0.66	1.10 - 0.80
JSIC-1	1,230	0.44 - 0.21	0.70 - 0.30	0.61 - 0.47	8.80 - 0.60
JSIC-2	9,050	0.36 - 0.09	0.70 - 0.30	0.66 - 0.22	0.80 - 0.40
Total	26,200	-	-	-	-

The typical canal sections are shown in ANNEX-XII.

8.2.2 Related structures

Various related structures would be required in conjunction with irrigation canals for conveyance, regulation and measurement of irrigation water and protection of canal system.

The general characteristics and design criteria of these structures are briefed as follows:

(1) Turnout

Turnouts would be provided to divert the required water from parent canals. Numbers of the turnouts which would divert the water from the main canal to the secondary canal are two. On the other hand, numbers of the turnouts from the main or secondary canal to the tertiary canal are 12.

The turnout consists of inlet from parent canal, slide gate, pipe culvert under canal inspection road or canal dike, and outlet transition to branch canal. The discharge measurement would be made by the method using the orifice flow. The difference of water levels between upstream side of the gate and downstream side would be measured by gauging staffs installed on the flume wall in the gate section.

(2) Drop

The function of drop structure is to dissipate excess energy. The vertical drop type with maximum drop head of 1.0 m was adapted considering rather small discharge. The drop consists of upstream transition, throat section, stilling basin and downstream transition.

(3) Culvert

Culverts would be constructed where a road crosses over the canal. These culverts would be strong enough for the increase of heavy traffic after the project implementation. The culvert consists of upstream transition, pipe culvert and downstream transition.

(4) Check gate

In order to maintain the required water level at the site of offtaking even during periods of off-peak discharge, check gates would be provided at just or near downstream of turnouts and at the end of secondary canals. In consistence with canal longitudinal profile, two types of the check gate were considered. One is the ordinary type and the other is the combination type of check gate and drop.

The ordinary type check gate consists of upstream transition, throat section and downstream transition, and would be equipped with one rectangular slide gate and operation deck in the throat. On the other hand, the check gate with drop would have the stilling basin between the throat and the downstream transition.

(5) Spillway

Spillways would be constructed in the canal system for the purpose of spilling out excess flow or flushing off all water in the canals in case of the emergency and the canal clearing and repairing. The spillway consists of side spillway, slide gate for waste of water, culvert under canal inspection road and outlet transition. For the culvert, two types of box and pipe are considered for the waste water discharges. The single box barrel type was adapted to the spillway which would be constructed at the upstream of Ndoup main irrigation canal. The single pipe barrel type was adapted to other four spillways which would be constructed at the ends of secondary canals. All spillways should be connected to the nearby drainage canals.

The numbers and types of all the structures for the proposed irrigation system are shown in Table 6.12.

8.3 Drainage Canals and Related Structures

8.3.1 Design of drainage canals

All drainage canals were designed as unlined canals with trapezoidal sections. The design of the drainage canals were made based on the basic design criteria described as follows:

(1) Design discharge

Based on the drainage water requirement calculated in Section 5.1 and the catchment area, the design discharges for drainage canals were estimated. Drainage diagram for the proposed drainage system is shown in Fig. 6.10.

(2) Design water level

1) Main and secondary drainage canals

The design water level in the drainage canal was determined based on the required water level at the drain inlet through which the drained water in the tertiary drainage block would flow into the drainage canal.

The required water level in the canal at the drain inlet was estimated at 1.0 m lower than the field surface elevation taking into account the required groundwater level at each farm plot and head losses caused at junctions and in canals in the on-farm drainage system.

2) Catch drain

The design water level was determined at 0.20 m lower in minimum from the ground surface elevation for all the catch drains.

(3) Velocity

Considering the frequency and the duration of design drainage condition, the maximum permissible velocity for drainage canals was set a little lower than that for irrigation canals.

Maximum velocity : 1.0 m/sec

Minimum velocity : 0.3 m/sec

(4) Roughness coefficient

The roughness coefficient of drainage canals was determined as below, considering the soil texture in the project area and the canal maintenance condition after the project implementation.

Roughness coefficient : $n = 0.030$

(5) Canal section

The canal section was designed taking into account the efficient construction works at the implementation in addition to the effective water flow and the canal slope stability.

1) Main and secondary drainage canals

For large discharge canals, the maximum water depth was set at 2.0 m in order to keep the canal height to be more or less 3.0 m for the efficient construction. The canal base width was determined according to the design discharge.

For rather small discharge canals, the canal base width was determined so that the ratio of water depth to base width would be nearly one under the condition that the water depth be less the base width.

The canal inside slope was determined at 1 : 1.5 considering the soil mechanical condition in the project area.

General features of the main and secondary drainage canals are as follows:

Name of Canal	Canal Length (m)	Design Discharge (m^3/sec)	Canal Base Width (m)	Water Depth (m)	Canal Height (m)
KMDC	3,690	42.9 - 30.7	19.0 - 13.0	1.90 - 1.84	3.88 - 3.48
KSDC-1	2,090	3.5 - 1.9	1.5 - 1.0	1.28 - 0.95	2.74 - 2.01
KSDC-2	910	3.9 - 3.5	1.5	1.38 - 1.28	3.40 - 2.66
JMDC	7,725	10.6 - 5.0	4.0 - 2.0	1.94 - 1.59	4.25 - 2.62
DMDC	5,540	20.1 - 15.0	8.0 - 7.0	1.90 - 1.60	3.85 - 2.30
Total	19,955	-	-	-	-

The typical cross sections of the main and secondary drainage canals are shown in ANNEX-XII.

2) Catch drains

For catch drains, the ratio of water depth to canal base width was determined at nearly one. The canal inside slope was determined at 1 : 1.0 taking into consideration the frequency and the duration of design drainage condition in addition to the stability of the inside slope from the viewpoint of soil mechanical characteristics in the surrounding hilly land where the drains would be constructed.

General features of catch drains are summarized in Table 6.13, and the typical cross section is shown in ANNEX-XII.

8.3.2 Related Structures

The structures related to the drainage network are as follows:

(1) Drainage junction

A drainage junction would be constructed at the confluence of the Ndoup and Nja main drainage canals for protection of the canal inside slope.

(2) Drain inlet

Drain inlet would be provided to receive the drained water from tertiary drainage canals on the main and secondary drainage canals crossing under the canal inspection road or the foot path.

In accordance with design discharges, three types of the drain inlet were designed from the viewpoint of economic construction. The single box barrel type is applied for large inflow discharge more than 1.00 m^3/sec, the double pipe barrels type is for discharge from 1.00 m^3/sec to 0.50 m^3/sec, and the single pipe barrel type is for small discharge less than 0.50 m^3/sec.

The drain inlet consists of inlet protection, culvert and outlet protection on the inside surface of parent canal.

(3) Drop

Drops of inclined chute type are applied considering large discharge. The drop consists of upstream transition, throat section, chute, stilling basin and downstream transition.

(4) Culvert

Culverts are crassified into two types depending on design drainage discharges. The triple box barrels type is adapted for large discharge more than 20.00 m^3/sec, the double box barrels type is for discharge from 20.00 m^3/sec to 8.00 m^3/sec, and the single box barrel type is for small discharge less than 8.00 m^3/sec. The culvert consists of upstream transition, box barrel section and downstream transition.

(5) Cross drain

Cross drains would be constructed across the irrigation canals and/ or main farm roads at the places where these canals and roads run across depressed lands or natural streams. The cross drains would be provided to connect with beginning points of the catch drains. Two types of cross drains are considered depending on design discharges. The double barrels type is applied for discharge more than 1.40 m^3/sec, and the single barrel type is for discharge less than 1.40 m^3/sec. The cross drain consists of inlet protection, barrel section and downstream protection.

The numbers and types of all the structures for the proposed drainage system are shown in Table 6.14.

8.3.3 Diversion flood way

The diversion flood way consists of side spillway, flood canal and cross drain crossing under the Nja secondary irrigation canal, JSIC-2.

(1) Side spillway

The side spillway would be constructed at station No. 9 + 160 m in the left side of Nja main drainage canal, JMDC. The design condition and general features are as follows:

1) Design diversion flood discharge

A half of the design discharge of the Nja main drainage canal, JMDC at just upstream of the spillway was taken as the design diversion flood discharge.

Design discharge : 5.83 m^3/sec

2) Side spillway weir

Crest elevation	:	1,115.70 m
Overflow depth	:	0.60 m
Crest length	:	8.00 m

3) Double box barrels

Width per barrel	:	2.00 m
Height	:	2.00 m
Length	:	2.00 m

(2) Flood canal

The flood canal would be constructed to transfer the diverted flood to the upper stream reach of natural river in the outside basin.

1) Design discharge

After crossing JSIC-2, the drainage water from a catch drain would flow into the flood canal. The design discharge are taken as follows:

B.P. - Cross drain	:	5.83 m^3/sec
Cross drain - E.P.	:	5.89 m^3/sec

2) Canal features

Length	:	700 m
Base width	:	1.60 m
Water depth	:	1.53 m
Canal inside slope	:	1 : 1.5

(3) Regulating gates

The regulating gates consist of upstream transition, throat section and downstream transition, and would be equipped with three roller gates and operation deck in the throat. The downstream transition would connect directly with the Baigom bridge.

Gate type	:	Roller gate
Number of gate	:	3 nos.
Size of gate	:	Width 3.0 m x Height 2.5 m

8.4 Farm Roads

8.4.1 Main farm road

Gravel pavement would be made on the main farm roads. General features of the roads are as follows:

Total width	:	5.00 m
Effective width	:	4.00 m
Embankment height	:	0.60 m
Side slope	:	1 : 1.0
Pavement thickness	:	5.0 cm

Length of each main farm road is shown below:

Name of Road	Length (m)
MFR-1	320
MFR-2	2,550
MFR-3	4,500
MFR-4	220
MFR-5	120
MFR-6	1,660
MFR-7	2,500
MFR-8	2,300
Total	14,170

The typical cross section of the main farm road is shown in ANNEX-XII.

8.4.2 Canal inspection road

The canal inspection road was also designed with the criteria as the main farm road.

1) For main and secondary irrigation canals

Name of Road	Length (m)
IR-DMI	3,650
IR-DSI-1	5,900
IR-DSI-2	1,950
IR-JMI	4,420
IR-JSI-1	1,230
IR-JSI-2	9,050
Total	26,200

The typical cross section of the inspection road for main and secondary irrigation canals in shown in Fig. 6.12.

2) For main and secondary drainage canals

Name of Road	Length (m)
IR-KMD	3,690
IR-KSD-1	2,090
IR-KSD-2	910
IR-DMD	5,540
IR-JMD	7,725
Total	19,955

The typical cross section of the inspection road for main and secondary drainage canals is shown in ANNEX-XII.

8.5 On-Farm Development

8.5.1 On-farm irrigation facilities

(1) Design of on-farm irrigation canals

The basic design conditions and criteria are as follows:

1) *Design discharge*

Tertiary canal : 156 ℓ/sec - 31 ℓ/sec

Quaternary canal : 31 ℓ/sec

Main farm ditch : 18 ℓ/sec

2) Design water level

Following design water level above the field surface was used for the typical design.

Tertiary canal : 0.30 m

Quaternary canal : 0.25 m

Main farm ditch : 0.20 m

3) Canal section

The ratio of water depth to the canal base width would be nearly one under the condition that the minimum base width would be 0.30 m.

General features of on-farm irrigation canals are as follows:

Class of Canal	Canal Base Width (m)	Canal Height (m)	Canal Inside Slope
Tertiary canal	0.50-0.30	0.60-0.40	1:1.0
Quaternary canal	0.30	0.40	1:1.0
Main farm ditch	0.30	0.30	1:0.5

The typical canal sections of on-farm irrigation canals are shown in Fig. 6.12.

4) Canal length

Total canal length for each class of on-farm irrigation canals was assessed for total project area 2,000 ha in net based on the typical on-farm layout.

Class of Canal	Canal Length (m/ha)	(km)
Tertiary canal	16.7	33.3
Quaternary canal	25.0	50.0
Main farm ditch	50.0	100.0
Total	91.7	183.3

(2) Related structures

In relation to the above canals, many structures such as division boxes, quaternary outlets, culverts and drops would be provided to divide and convey water and to protect the canals.

1) Division box

Division boxes would be provided to divert the required water from the tertiary canal to quaternary canals. The division box consists of inlet protection, box pond and outlet protection, and would be equipped with each one rectangular slide gate in each outlet to branch canal and to downstream canal. The protection would be with precast concrete panels.

The discharge measurement would be made by the overflow depth on the outlet crest in the complete overflow condition.

2) Quaternary outlet

Quaternary outlets would be provided to divert the required water from the quaternary canal to main farm ditches. The quaternary outlet consists of inlet production, stop log and outlet protection. The stop log would be used for regulation of the water.

3) Culverts

Culverts would be provided on tertiary and quaternary canals crossing under on-farm roads. The culvert consists of single pipe barrel and vertical walls at upstream and downstream ends.

4) Drop

Drops would be provided on the quaternary canals in the sloped land. The drop consists of inlet protection, vertical wall with rectangular throat and outlet protection. The protection would be with precast concrete panels.

The numbers of all related structures for the proposed on-farm irrigation system are as follows:

(Unit: nos.)

Area		Division Box	Quaternary Outlet	Culvert	Drop
Flat land field	1,700 ha	71	284	128	0
Sloped land field	300 ha	13	50	23	213
Total	2,000 ha	84	334	151	213

8.5.2 On-farm drainage facilities

(1) Design of on-farm drainage canals

The basic design conditions and criteria are as follows:

1) Design discharge

Tertiary drainage canal	:	288 ℓ/sec - 142 ℓ/sec
Quaternary drainage canal	:	116 ℓ/sec
Main drainage ditch	:	20 ℓ/sec

2) Design water level

To keep the enough low groundwater level for upland crops such as maize, etc., following design water level below the field surface was used for the typical design.

Tertiary drainage canal	:	-0.80 m
Quaternary drainage canal	:	-0.70 m
Main drainage ditch	:	-0.60 m

3) Canal section

The ratio of water depth to the canal base width would be nearly one under the condition that the minimum base width would be 0.30 m.

General features of on-farm drainage canals are as follows:

Class of Canal	Canal Base Width (m)	Canal Length (m)	Canal Inside Slope
Tertiary canal	0.50-0.40	1.40-1.25	1:1.0
Quaternary canal	0.40	1.10	1:1.0
Main drainage ditch	0.30	0.80	1:0.5

The typical canal sections of on-farm drainage canals are shown in Fig. 6.12.

4) Canal length

Total canal length for each class of on-farm drainage canals was assessed for total project area 2,000 ha in net based on the typical on-farm layout.

Class of Canal	Canal Length (m/ha)	Canal Length (km)
Tertiary drainage canal	10.0	20.0
Quaternary drainage canal	18.7	37.5
Main drainage ditch	50.0	100.0
Total	78.7	157.5

(2) Related structures

In relation to the above drainage canals, structures such as drainage junctions, culverts and drops would be provided to convey drainage water and to protect the canals.

1) Drainage junction

Drainage junctions would be provided at inflow points from quaternary drainage canal to tertiary drainage canal and from main drainage ditch to quaternary drainage canal. The drainage junction would be constructed as a protection work with thin gabion.

2) Culvert

Culverts would be provided on tertiary and quaternary canals crossing under on-farm roads. The culvert consists of single pipe barrel and vertical walls at upstream and downstream ends.

3) Drop

Drops would be provided on the quaternary drainage canals in the sloped land area. The drop consists of inlet protection, vertical wall with rectangular throat and outlet protection. The protection would be with precast concrete panels.

The numbers of all related structures for the proposed on-farm drainage system are as follows:

(Unit: nos.)

Area		Drainage Junction	Culvert	Drop
Flat land field	1,700 ha	254	113	0
Sloped land field	300 ha	46	21	213
Total	2,000 ha	300	134	213

8.5.3 On-farm road

(1) On-farm road

On-farm road was designed as non-paved road. General features of the road are as follows:

Total width : 2.60 m

Effective width : 2.00 m

Embankment height : 0.50 m

Side slope : 1 : 1.0

Total on-farm road length was assessed for all the project area 2,000 ha in net based on the typical on-farm layout.

On-farm Road (m/ha)	Length (km)
36.7	73.3

The typical cross section of the on-farm road is shown in Fig. 6.12.

(2) On-farm canal inspection road

On-farm canal inspection roads would be provided as foot path along the tertiary and quaternary irrigation canals. The width of the road is 1.0 m.

Class of Inspection Road	Road Length	
	(m/ha)	(km)
For tertiary irrigation canal	16.7	33.3
For quaternary irrigation canal	25.0	50.0
Total	41.7	83.3

The typical cross sections of the on-farm canal inspection roads are shown in Fig. 6.12.

8.6 Work Quantities

On the basis of the preliminary design mentioned above, the drawings were prepared for major facilities such as the dams, the intake weir, main and secondary irrigation and drainage canals, these related structures, the diversion flood way, and the regulating gate. The drawings are attached in ANNEX-XII. The work quantities of the major facilities were estimated from these drawings.

The work quantities of on-farm facilities were estimated by the sample calculations based on the typical on-farm layout.

The work quantities of those facilities are summarized as shown in Table 6.15.