APPENDIX IV-3
RESULTS OF FARM HOUSEHOLD SURVEY

LIST OF TABLES

Table IV-3.1 (1/3) Off-farm Income and Off-income Source, Kandal Stung

Code No.	Off-farm income	Building	Construction	Saller	House keeper	Cyclo taxi	Cook	Broker	Officer	Farm labour	From abroad
46	800	500		300							
47	1250			250	1000						
48	200			200							
49											
50	120				120						
51	756								756		
52	852								852		
53											
54	1205								1205		
55	400		400								
56	1200			200	1000						
57	600			600							
58	300					300					
59	540			540							
60	1500							1500			
61	100			100							
62	20				20						
63	30			30							
64	200			200							
65	10									10	
66	20									20	
67	960								960		
68	200		200								
69	500		500								
70	210					210					
71	100			100							
72	460		460								
73											
74	300	300									
75	726								726		
76	120			120							
77	400									400	
78	60						60				
80	120			120							
81	300						300				
82	800		800								
83	720			720							
84	320									320	
85	384								384		
86											
87	200		200								
88											
89	100							100			
90	100		100								
91	610								610		
92	106			106							
93	76			76							
94	300									300	
95	840								840		
96	132								132		
97	90		90								
98	1220								1220		
99	1095					1095					
100	1515							1515			
101	960					960					
102											
103	180			180							
104	110			110							
105	360					360					
106	120									120	
107	320			320							
Total A 61	25217	800	2750	4272	2140	2925	360	3115	7685	1170	0
No. of farm	55	2	8	18	4	5	2	3	10	6	0

Table IV-3.1 (2/3) Off-farm Income and Off-income Source, Kandal Stung

Code No.	Off-farm income	Building	Construction	Seller	House keeper	Cyclo taxi	Cook	Broker	Officer	Farm labour	From abroad
108	800									800	
109	200			200							
110	36								36		
111	150		150								
112	200					200					
113	20			20							
114	250		250								
116	480			480							
117	606			606							
118	36				36						
119	210			210							
120	684								684		
121	215								215		
122	935								935		
123	1430		1430								
125	150										150
126	200										200
127	160			160							
128	150			150							
129	50									50	
130	470			470							
131	350			350							
132	300		300								
133	720								720		
134	96			96							
135	70		70								
136	170			170							
137	530			530							
138	110								110		
139	109			100							9
140	30			30							
145											
146											
147	360								360		
148											
149											
150											
151											
152											
153											
154											
161											
162	60					60					
163											
164											
165											
Total B 46	10337	0	2200	3572	36	260	0	0	3060	850	359
No.of farm (b)	33	0	5	14	1	2	0	0	7	2	3

Total A 61	25217	800	2750	4272	2140	2925	360	3115	7685	1170	0
Total B 46	10332	0	2200	3572	36	260	0	0	3060	850	359
TotalA+B 107	35549	800	4950	7844	2176	3185	360	3115	10745	2020	359
percentage	100%	2%	14%	22%	6%	9%	1%	9%	30%	6%	1%
Incom/107farm.	332	7	46	73	20	30	3	29	100	19	3
No.of farm(a)	55	2	8	18	4	5	2	3	10	6	0
No.of farm(b)	33	0	5	14	1	2	0	0	7	2	3
Total (a)+(b)	88	2	13	32	5	7	2	3	17	8	3

Table IV-3.1 (3/3) Off-farm Income and Income Source, Tonle Bati

Unit:1000 riel

Code No,	Off-farm income	Building	Construction	Saller	House keeper	Cyclo taxi	Cook	Broker	Officer
1									
2									
3									
4	250	250							
5									
6									
7									
8									
9									
10									
11									
12	10			10					
13	70	70							
14									
15	100			100					
16	100		100						
17	50		50						
18	100							100	
19	30		30						
20									
21									
22									
23	100						100		
24									
25	110					110			
26									
27	50			50					
28									
29	480								480
30									
31	50			50					
32									
33									
34	100		100						
35									
36									
37									
38									
39									
40									
41									
42									
43									
Total	1600	320	280	210	0	110	100	100	480
Percentage	100%	20%	18%	13%	0%	7%	6%	6%	30%
Income/Farm	37.2	7.4	6.5	4.9	0.0	2.6	2.3	2.3	11.2
No of farm	14.0	2	4	4	0	1	1	1	1

Table IV-3.2 (1/3) Main Income Sources of Farm Household, Kandal Stung

Code No.	Income Base								Farm Type				
	Farm Income			Off-Farm Income				Total	Rice + Stock + Other crop+ Off-farm	Rice + Stock+ Off-farm	Rice + Stock + Other crop	Rice + Stock	Off- farm only
	Rice	Other crop*	Live stock	Salary	Labour wage	Small shop	Others**	Off-farm income					
46	1		1			1		1		3			
47	1					1		1				2	
48	1					1		1				2	
49	1	1	1								3		
50	1		1		1			1		3			
51	1			1				1				2	
52	1		1	1				1		3			
53	1		1									2	
54	1		1	1				1		3			
55	1		1		1			1		3			
56	1		1			1		1		3			
57	1		1			1		1		3			
58	1		1		1			1		3			
59	1		1			1		1		3			
60	1		1		1			1		3			
61	1					1		1				2	
62	1				1			1				2	
63	1		1			1		1		3			
64	1	1	1			1		1	4				
65	1	1	1		1			1	4				
66	1	1	1		1			1	4				
67	1	1	1	1				1	4				
68	1		1		1			1		3			
69	1	1	1		1			1	4				
70	1	1	1		1			1	4				
71	1		1			1		1		3			
72	1		1		1			1		3			
73	1		1									2	
74	1		1		1			1		3			
75	1			1				1				2	
76	1		1			1		1		3			
77	1		1		1			1		3			
78	1		1		1			1		3			
79	1		1		1			1		3			
80	1	1	1			1		1	4				
81	1				1			1				2	
82	1		1		1			1		3			
83	1		1			1		1		3			
84	1				1			1				2	
85	1			1				1				2	
86	1		1									2	
87	1		1									2	
88	1		1									2	
89	1		1		1			1		3			
90	1		1		1			1		3			
91	1			1				1				2	
92	1					1		1				2	
93	1					1		1				2	
94	1				1			1				2	
95	1		1	1				1		3			
96	1	1	1	1				1	4				
97	1		1		1			1		3			
98				1				1					1
99	1		1		1			1		3			
100	1		1		1			1		3			
101	1		1		1			1		3			
102	1		1									2	
103	1					1		1				2	
104	1		1			1		1		3			
105	1		1		1			1		3			
106	1				1			1				2	
107	1		1			1		1		3			
62	61	9	46	10	27	18	0	55	8	31	1	21	1

Note: * Including Banana, mushroom etc,.
**Including income from abroad.

Source: Farm household survey conducted by study team 1994

Table IV-3.2 (2/3) Main Income Source of Farm Household, Kandal Stung

Code No.	Income Base: Farm Income: Rice	Farm Income: Other crop	Farm Income: Live-stock	Off-farm Income: Salary	Off-farm Income: Labour wage	Off-farm Income: Small shop	Off-farm Income: Others*	Total Off-farm+ income	Farm type: Rice + Stock + Other crop + Off-farm.	Rice + Stock + Off-farm	Rice + Stock / Other crop	Rice + Off-farm	Rice only	
108	1	1	1		1			1	4					
109	1	1	1			1		1	4					
110	1		1	1				1		3				
111	1		1		1			1		3				
112	1		1		1			1		3				
113	1		1			1		1		3				
114	1				1			1				2		
115	1		1			1		1		3				
116	1	1	1			1		1	4					
117	1		1		1			1		3				
118	1		1			1		1		3				
119	1		1		1			1		3				
120	1		1	1				1		3				
121	1		1	1				1		3				
122	1		1	1				1		3				
123	1		1		1			1		3				
124	1		1		1			1		3				
125	1		1				1	1		3				
126	1						1	1				2		
127	1	1	1			1		1	4					
128	1		1			1		1		3				
129	1		1		1			1		3				
130	1		1			1		1		3				
131	1		1			1		1		3				
132	1		1		1			1		3				
133	1			1				1				2		
134	1	1	1			1		1	4					
135	1		1		1			1		3				
136	1		1			1		1		3				
137	1		1			1		1		3				
138	1		1	1				1		3				
139	1		1			1		1		3				
140	1		1			1		1		3				
141	1		1											
142	1		1											
143	1		1								2			
144	1		1								2			
145	1		1								2			
146	1		1								2			
147	1			1				1			2			
148	1		1								2			
149	1												1	
150	1		1								2			
151	1		1								2			
152	1												1	
153	1		1								2			
154	1												1	
155	1												1	
156	1												1	
157	1												1	
158	1		1								2			
159	1		1								2			
160	1		1								2			
161	1		1								2			
162	1		1		1			1		3				
163	1		1								2			
164	1		1								2			
165	1											1		
Total b	58		47	7	12	14	2	35	5	26	15	4	6	
	61	9	46	10	27	18	0	55	8	31	1	21	1	Total
	58		47	7	12	14	2	35	5	26	15	4	6	
Kandal	119	9	93	17	39	32	2	90	13	57	16	25	7	118
Percentage of the total number of income source category:									11%	48%	14%	21%	6%	100%

Source: Farm household survey conducted by study team1994.

Table IV-3.2 (3/3) Main Income Sources of Farm Household, Tonle Bati

	Income Base										
	Farm Income			Off-Farm Income			Farm Type				
Code No.	Rice	Live stock	Salary	Labour wage	Small Shop	Total Off-farm income	Rice + Stock + Off-farm	Rice + Stock	Rice + Off-farm	Rice only	Total
1	1	1						2			
2	1	1						2			
3	1	1						2			
4	1	1		1		1	3				
5	1	1						2			
6	1	1						2			
7	1									1	
8	1	1						2			
9	1	1						2			
10	1	1						2			
11	1	1						2			
12	1	1			1	1	3				
13	1	1		1		1	3				
14	1	1						2			
15	1	1			1	1	3				
16	1	1		1		1	3				
17	1	1		1		1	3				
18	1	1		1		1	3				
19	1	1		1		1	3				
20	1	1						2			
21	1	1						2			
22	1	1						2			
23	1	1		1		1	3				
24	1	1						2			
25	1	1		1		1	3				
26	1	1						2			
27	1				1	1			2		
28	1	1						2			
29	1	1	1			1	3				
30	1	1						2			
31	1	1			1	1	3				
32	1	1						2			
33	1	1						2			
34	1	1		1		1	3				
35	1	1						2			
36	1	1						2			
37	1								1		
38	1	1						2			
39	1	1						2			
40	1	1						2			
41	1									1	
42	1									1	
43	1									1	
44	1									1	
Total	44	37	1	9	4	14	13	24	2	5	44
Percentage of the total number of income source c:							30%	55%	5%	11%	100%

Source:Farm household survey conducted by study team 1994.

Table IV-3.3 (1/3) Living Expenditure, Kandal Stung

Unit: 1,000 Riel

Code No.	No. of family member	FOOD ITEMS							NON-FOOD ITEMS							
		Rice/ Other cereals	Vegetable/Fruits	Meat	Fish/ crab/etc,.	Soft/ Beberages	Food/ Ingredients	Sub Total	Medicine/Health	School fee/Education	Housing	Clothing	Furniture/ Equip.	Transportation	Other	Sub Total
46	4	480	180	180	120	60	120	1140	240			180			30	450
47	6	384	180	120	360		72	1116	100	48	40	200			300	688
48	5	288	360	300	12	90	120	1170	500	200		700	180	5	10	1595
49	3	288	108	25	12		42	475	100	48		20			180	348
50	5	576	96	18	360		84	1134	250	100		50			200	600
51	3	296	180	180	288	6	72	1022	250		70				50	370
52	8	570	180	180	432	36	60	1458	42	384	15	100	50		100	691
53	5	576	54	90	72	36	42	870	120	360	10	60			50	600
54	5	192	180	90	360	36	108	966	100	90	30	120			100	440
55	3	336	60	30	180		24	630	50			30			50	130
56	5	384	216	30	360		36	1026	200			100			150	450
57	2	196	36	180	180	18	20	630	1200			50			40	1290
58	5	384	120	120	300	18	120	1062	250			50			50	350
59	6	384	144	18	216		72	834	40	40		5			10	95
60	5	336	240	240	480	5	60	1361	500			200			300	1000
61	2	360	24	18	36		30	468	84			45	20	10	3	162
62	2	190	12	240	2		18	462	22	24		2	5		10	63
63	7	540	48	24	30	20	42	704	300	360		100	10	70	100	940
64	3	312	36	120	60		20	548	360	180		100	50	30	20	740
65	3	220	24	60	18		12	334	24	30		50	2	2	60	168
66	2	180	42	96	78		54	450	3			60	4	3	80	150
67	3	252	60	96	89		30	527	60			100	45	20	160	385
68	4	427	36	96	96	12	30	697	180			40	20	5	150	395
69	4	360	72	144	72	36	42	726	90	36		80	30	15	88	339
70	7	360	72	144	360	360	120	1416	120	30		50	40	30	100	370
71	8	480	120	180	240	48	180	1248	48	20	100	150			300	618
72	8	504	120	180	240	54	180	1278	48		90	160			250	548
73	7	250	240	444	300		240	1474			40	250	500	10		800
74	8	252	120	480			240	1092			35		25		110	170
75	8	252	240	60	360		60	972	40	30	60	100			300	530
76	8	756	180	180	480	120	120	1836		750		100			70	920
77	6	580	216	180	180	84	120	1360		75		200			100	375
78	9	480	22	180	240	96	180	1198		24	224	100			100	448
80	4	756	192	180	480	120	120	1848		365		100			100	565
81	6	720	180	240	72	24	120	1356		37	30	20			100	187
82	9	600	180	300	240	360	120	1800	600		292	100			150	1142
83	6	600	60	120	120	180	84	1164			40	30			50	120
84	5	360	60	36	24		36	516	60		40	50		20	100	270
85	4	186	36	72	24		48	366	72		10	30		10	40	162
86	7	600	120	180	240	60	120	1320		183	20	50			50	303
87	6	720	180	60	180	180	120	1440		5	300	100			150	555
88	3	240	180	120	72	36	36	684			30	60			30	120
89	7	240	240	180	180	60	72	972		100	30	60			70	260
90	5	480	120	120	108	180	84	1092		174	80	100			60	414
91	8	796	120	180	144		120	1360			10	100	200		50	360
92	5	600	180	360	360		180	1680		660	80	12			24	776
93	4	252	84	120	120		120	696	3	12		15			10	40
94	5	324	180	180	144		60	888	12	7		50			40	109
96	8	206	120	58			110	494	20	20		100			60	200
97	8	391	120	4	60		48	623		20		50			50	120
98	7	399	77	240	288	16	42	1062	360			176		56	80	672
99	4	600	216	480	168	30	84	1578	36				50		200	286
100	5	300	269	504	216	30	72	1391	360	5	200	70			100	735
101	6	420	140	36	240			836	180		30	50			30	290
102	4	360	240	120	60			780	120	24	100	50			50	344
103	6	620	360	360	360			1700	360		12	5				377
104	5	360	120	300	360			1140	360	180	40	100				680
105	4	360	240	480	340			1420	18		50	100				168
106	2	216	48	240	120	60	180	864	60	480		30	10	5	120	705
107	6	360	108	180	84	60	60	852	216	72		50	15	18	80	451
Total A	318	24491	8188	10173	11417	2531	4806	61606	8158	5173	2108	5210	1256	309	5415	27629
No. of sample		60						60								60

Table IV-3.3 (2/3) Living Expenditure, Kandal Stung

Unit: 1,000 Riel

Code No.	No. of family member	FOOD ITEMS: Rice / other cereals	Vegetable / Fruits	Meat	Fish / crab/etc,.	Soft / Beberages	Food / Ingredients	Sub Total	NON-FOOD ITEMS: Medicine / Health	School fee/Education	Housing	Clothing	Furniture / Equip.	Transportation	Others	Sub Total
109	2	180	60	120	72	24	30	486	180	240		50	10	5	90	575
110	4	240	60	120	72	60	72	624	60	180		40	3	3	30	316
111	6	450	70	20	8	5	60	613	36	120		40		20	50	266
112	4	270	18	120	144	60	36	648	84	48		15	5	2	40	194
113	4	486	36	12	12	18		564	60	24		30	3	3	6	126
114	3	270	54	120	96	18	24	582	240			40	10	5	30	325
116	8	648	12	180	240		96	1176	60	36	60				130	286
117	5	324	180	120	120		36	780	180			50			80	310
118	3	462	180	36	120	50	60	908	20	13		10			200	243
119	9	684	120	48	240	50	84	1226	240	26		30			60	356
120	6	480	67	144		240	48	979	24	20		10		216	100	370
121	5	432	108	48	360	5	40	993	60			20			50	130
122	8	291	379	96	288	3	58	1115	30	62		78		18	216	404
123	5	399	168	36	480		110	1193	120			45			50	215
125	9	756	168	150	180	8	54	1316	12	23		42			80	157
126	3	180	10	120	6	6	12	334	240			5	5	12	36	298
127	6	420	36	24	12	12	36	540	120	84		100	20	12	90	426
128	2	240	120	96	96	14	60	626	144			50	30	50	100	374
129	2	180	10	36	42	12	18	298	3	240		20	3	2	80	348
131	8	420	360	120	240		60	1200	360	20	50		100	3	100	633
132	9	500	50	130	5	36	100	821	70	150		90	5	60	30	405
133	5	270	36	180	120	36	42	684	108			30	9	2	50	199
134	8	360	48	12	12	36	37	505	240	180		100	15	20	90	645
135	6	360	32	66	42		36	536	66	25		100	9	20	20	240
136	10	864	120	144	156	8	84	1376	120	22		100		15	200	457
137	6	540	60	240	240		60	1140	60						50	110
138	10	864	120	210	120		50	1364	26	270	30	80			100	506
139	4	432	180	120	60		60	852	60	72	60	45			50	287
140	2	108	24	60	72		12	276	36		25	20			20	101
146	4	480	120	120	360		180	1260	180	18	20	40			30	288
147	6	480	120	180	80			860	120		20	40			40	220
148	4	432	60	240	360			1092	96	108	20	50			40	314
149	4	384	50	120	240			794	72		30	50			50	202
150	9	662	24	120	120			926	60	480	20	30				590
151	2	240	10	60	36			346	360						40	400
152	2	120	60	48	22			250	140		20	50		10	50	270
153	6	720	180	120	126			1146	180	135	30				20	365
154	2	220	120	140	12			492	60	180	15	50			60	365
161	10	672	180	12	180			1044	60	60	40	20			50	230
162	9	576	360	120	60			1116	120	84	30	30				264
163	9	672	240	60	36			1008	84							84
164	4	270	40	120			54	484	60							60
Total B	233	18038	4450	4388	5287	701	1709	34573	4651	2920	470	1600	227	478	2608	12954
No. of sample		42						42								42

Total A	318	24,491	8,188	8,037	11,417	2,531	4,806	61,230	8,158	5,173	2,108	5,210	1,256	309	5,415	27,629
Total B	233	18,038	4,450	4,388	5,287	701	1,709	34,573	4,651	2,920	470	1,600	227	478	2,608	9,868
A+B	551	42,529	12,638	12,425	16,704	3,232	6,515	95,803	12,809	8,093	2,578	6,810	1,483	787	8,023	37,497
Average	5.4	417.0	123.9	121.8	163.8	31.7	63.9	939.2	125.6	79.3	25.3	66.8	14.5	8	79	367.6
% of items		44%	13%	13%	17%	3%	7%	100%	34%	22%	7%	18%	4%	2%	21%	100%
% of sub total								72%								28%
Cons/Capita/Year in riel		77	23	23	30	6	12	174	23	15	5	12	3	1	15	68
No. of sample A+B		102						102								102

Table IV-3.3 (3/3) Living Expenditure, Tonle Bati

Unit:1,000 Riel

		FOOD ITEMS							NON-FOOD ITEMES							
Code No.	No. of family member	Rice/ Other cereals	Vegeta ble/Fr uits	Meat	Fish/ crab/etc,.	Soft/ Bevera ges	Food/ Ingred ients	Sub total A	Medici ne/Hea lth	School fee/Ed ucation	Hous	Cloth ing	Furni ture/ Equip.	Trans porta tion	Others	Sub total B
2	6	612	180	220	135	72	90	1,309	120	96		80		12	29	337
3	6	259	120	45	108		60	592	50	96		50		12	60	268
4	5	303	180	220	80		90	873	200	144		50		18	50	462
5	7	459	140	154	220		180	1,153	120	288		100		12	70	590
7	2	428	72	190	115		48	853	160	14		20			20	214
10	3	459	144	200	80	24	54	961	60	14		35	144		25	278
12	5	816	180	140	108		54	1,298	100	24		60		36	40	260
16	9	357	144	100	215	108	54	978	150	86		120		12	60	428
17	2	612	80	115	54		54	915	50			20		6	20	96
18	7	612	144	100	160	120	54	1,190	50	288		70		36	60	504
19	8	510	160	85	160	108	90	1,113	100	144		100		12	40	396
21	7	612	160	144	160	108	90	1,274	150			100		12	85	347
22	6	816	160	115	160		90	1,341	100	115		100		36	110	461
25	8	510	144	144	108	120	54	1,080	100	115		60		12	90	377
26	4	306	180	100	108	60	90	844	100			100		24	60	284
27	5	510	180	90	108	72	120	1,080	100			50		36	50	236
28	5	510	180	144	108		90	1,032	100	115		70		12	40	337
29	4	306	180	90	108		90	774	100	96		50		36	30	312
32	8	714	260	144	108	108	60	1,394	100	58		80		12	60	310
33	4	408	180	60	108	44	90	890	150	46		50		20	40	306
35	6	714	180	100	108		54	1,156	100	58		50		18	30	256
37	3	321	120	90	54	120		705	120			35		24	25	204
38	6	536	180	100			30	846	60	38		80		5	25	208
39	3	321	160	90	35		35	641	156	30		35			20	241
41	5	536	120	144	55		132	987	120	48	50		42		25	285
42	7	750	120	144	35		60	1,109	180	123		70		10	25	408
Total	141	13,297	4,048	3,268	2,798	1,064	1,913	26,388	2,896	2,036	50	1,635	186	413	1,189	8,405
Ave.	5.4	511.4	155.7	125.7	107.6	40.9	73.6	1014.9	111.4	78.3	1.9	62.9	7.2	15.9	45.7	323.3
% by item		50%	15%	12%	11%	4%	7%	100%	34%	24%	1%	19%	2%	5%	14%	100%
% of sub total								74%								24%
Cons /Capita/year in riel		94.7	28.8	23.3	19.9	7.6	13.6		20.6	14.5	0.4	11.6	1.3	2.9	8.5	59.9
No. of sample		26						26								26

Table IV-3.4 (1/2) Farmer's Intention About Farm Operation, Kandal Stung

Code	No.1011							NO. 1012			
No.	a	b	c	d	e	f	g	a	b	c	d
46		1		1	1						1
47		1		1	1						1
48		1	1			1					1
49		1			1		1				1
50		1		1	1						1
51		1		1	1						1
52		1	1	1							1
53		1		1			1				1
54		1		1	1						1
55		1		1	1					1	
56		1		1	1						1
57					1	1	1				1
58		1		1	1						
59											
60		1			1		1				1
61		1		1							
62		1	1		1					1	
63		1		1	1					1	
64		1	1	1	1		1	1		1	
65		1		1		1	1			1	
66		1		1			1			1	
67		1		1			1		1	1	
68		1	1	1						1	
69		1		1	1					1	
70		1	1	1			1			1	1
71	1	1					1			1	
72	1	1								1	
73	1	1		1						1	
74	1	1	1							1	
75	1	1			1					1	
76	1	1			1					1	
77		1			1		1				
78	1	1					1			1	
79		1			1		1			1	
80	1	1			1						
81		1			1		1				1
82	1	1					1			1	
83		1			1		1				1
84		1			1		1				
85		1			1		1				
86	1	1					1			1	
87	1	1					1			1	
88		1					1				1
89	1	1					1			1	
90		1			1		1				1
91	1	1			1					1	
92	1	1			1					1	
93											
94											
95	1	1			1		1			1	1
96		1	1		1					1	
97	1	1	1							1	
98	1	1					1			1	1
99		1		1			1			1	
100		1		1			1			1	1
101											
102	1	1					1				1
103	1	1					1				
104	1	1					1			1	
105	1	1				1				1	
106		1	1		1						
107		1		1	1					1	
Total	21	57	10	23	31	4	30	1	1	33	21

Code	No.1011							No.1012			
NO.	a	b	c	d	e	f	g	a	b	c	d
108		1	1	1			1				
109		1		1	1					1	
110		1	1		1					1	
111		1		1	1					1	
112		1	1		1					1	
113		1	1	1	1					1	
114		1		1	1					1	
115		1		1	1					1	
116		1		1			1				1
117		1		1	1						1
118		1		1	1						1
119		1		1			1			1	1
120		1	1	1			1			1	1
121		1	1	1				1		1	
122		1			1						
123		1		1	1					1	
124		1		1	1					1	
125		1		1			1			1	1
126		1	1	1						1	
127		1	1		1					1	
128		1		1	1					1	1
129		1	1	1						1	
130		1		1	1		1			1	
131		1		1			1			1	
132		1		1			1			1	
133		1		1	1					1	
134		1	1	1						1	
135		1		1			1			1	
136	1	1					1				
137	1	1			1		1			1	1
138	1	1		1						1	
139		1		1	1					1	
140	1			1	1					1	
141		1	1		1						1
142		1	1		1						1
143		1			1		1				
144		1	1				1				1
145		1	1		1						
146	1	1					1	1			1
147	1	1					1	1			1
148	1	1					1	1			1
149	1	1					1	1		1	
150	1	1					1	1		1	
151	1	1					1	1		1	
152	1	1					1	1		1	
153	1	1					1	1		1	
154	1	1			1			1			1
155											
156		1	1		1		1				
157		1	1		1		1				
158	1		1	1	1		1	1		1	
159	1	1			1						
160	1		1	1			1	1		1	
161	1	1				1		1			
162	1	1					1	1			1
163	1	1				1		1			1
164	1	1	1	1			1			1	1
165	1	1			1		1			1	
166		1		1	1				1		
167		1		1	1					1	
168		1	1	1							
169		1		1	1					1	
Total	21	58	20	34	32	2	28	15	1	38	18

Note: Total effictive sample is 123.

No.1011 (Major constraints)

a Excess water
b Shoetage of irrigation water
c Pest and diseases
d Shortage of agricultural inputs
e Shortage of farm tools and draught animal
f Hardship for weed control
g Other

No. 1012 (Flood damage)

a Every year
b More than half of the year
c Less than half of the year
d Never

Tota	21	57	10	23	31	4	30	1	1	33	21
Tota	21	58	20	34	32	2	28	15	1	38	18
A+B	42	115	30	57	63	6	58	16	2	71	39
%	34	93	24	46	51	4.9	47	13	1.6	58	32

Table IV-3.4 (2/2) Farmer's Intention About Farm Operation, Tonle Bati

Code	No.1011							No.1012			
No.	a	b	c	d	e	f	g	a	b	c	d
1		1		1			1				1
2		1		1			1				1
3		1		1			1				
4		1		1			1				
5		1		1	1						1
6		1		1			1				1
7			1	1			1				1
8		1		1			1				1
9		1	1								1
10		1					1				1
11		1		1							1
12		1			1		1				1
13		1		1		1					1
14		1	1								1
15		1	1	1							1
16		1				1	1				1
17		1		1			1				1
18		1	1		1						1
19		1			1		1				1
20		1		1			1				1
21		1		1			1				1
22		1	1			1					1
23		1	1	1			1				1
24		1		1			1				1
25		1		1			1				1
26		1		1		1	1				1
27		1		1	1		1				1
28		1		1		1					1
29		1		1		1					1
30		1	1	1							1
31		1		1		1					1
32		1		1		1					1
33		1		1			1				1
34		1		1			1				1
35		1	1	1							1
36	1	1			1		1				
37											
38	1	1	1								
39	1	1					1				
40	1	1					1				
41		1	1								
42		1									
43			1		1		1	1			
Total	4	40	12	27	7	8	25	1	0	0	33
%	9	93	28	63	16	19	58	2	0	0	77

Note:

No.1011 (Major constraints)

a Excess water
b Shortage of irrigation water
c Pest and diseases
d Shortage of agricultural inputs
e Shortage of farm tools, draught animal
f Hardship for weed control
g Poor soil

No.1012 (damage No.1012 (damaged by flood water)

a Every year
b More than half the year
d Less than half the year
c Never

Table IV-3.5 (1/2) Farmer's Intention About Crop Production in Future, Kandal Stung

Code	No.1021(w)			No. 1021(d)							No.1022				No.1023			NO. 1031				
No	a	b	c	a	b	c	d	e	f	g	b	c	d	e	a	b	c	a	b	c	d	e
46	1											1				1		1				
47	1											1				1		1				
48	1											1				1	1	1				
49	1											1						1				
50	1											1				1		1				
51	1											1				1		1				
52	1	1										1				1		1				
53	1	1										1						1				
54	1											1				1		1				
55	1											1						1				
56	1											1				1		1				
57	1											1					1					
58	1											1				1						
59																						
60	1											1				1		1				
61	1							1					1			1						
62	1			1							1	1	1			1						
63	1							1			1	1	1			1		1				
64	1			1	1		1	1		1	1	1	1			1		1	1			
65	1							1		1	1	1			1	1		1				
66	1							1		1	1	1				1		1				
67	1							1		1	1	1				1		1				
68	1			1				1			1	1				1		1				
69	1			1				1	1		1	1	1			1		1				
70	1				1			1			1	1				1		1				
71	1	1								1	1		1			1		1				
72	1	1								1	1					1		1				
73	1	1									1	1				1		1				
74	1	1									1	1				1		1				
75	1	1									1	1		1		1		1				
76	1	1									1					1		1				
77	1										1	1				1		1				
78	1	1		1							1	1				1		1				
79	1	1								1	1					1		1				
80	1	1									1	1				1		1				
81	1										1							1				
82	1	1									1							1				
83	1	1								1	1							1				
84	1										1	1				1		1				
85	1										1	1				1		1				
86	1	1		1						1	1							1				
87	1	1								1	1							1				
88	1	1									1							1				
89	1	1								1	1							1				
90	1	1								1	1	1				1		1				
91	1	1									1	1				1		1				
92	1										1	1				1		1				
93											1	1				1		1				
94											1			1								
95	1										1	1		1		1		1				
96	1										1	1		1		1		1				
97	1										1	1				1		1				
98	1										1	1			1	1		1				
99	1			1							1	1	1			1		1				
100	1										1	1				1		1				
101											1											
102	1							1			1					1		1	1		1	
103	1										1					1		1				
104	1										1					1		1				
105	1										1					1		1				
106	1	1		1			1	1			1	1	1			1		1		1		1
107	1				1			1			1			1		1		1				
	58	20	0	8	3	0	2	12	1	12	46	42	8	5	2	43	1	50	3	1	0	1

Code	N.1021(w)			No 1021 (d)							No.1022				N.1023			No. 1031				
No.	a	b	c	a	b	c	d	e	f	g	a	b	c	d	a	b	c	a	b	c	d	e
108	1	1									1	1				1		1				
109	1	1						1			1		1	1		1		1				
110	1				1	1	1	1		1	1	1	1			1		1	1	1	1	1
111	1						1	1			1					1		1				
112	1				1			1						1		1		1				
113	1				1			1			1	1				1		1				
114	1				1			1			1	1	1			1		1				
115	1							1			1		1			1		1				
116	1	1		1							1	1	1			1		1		1		
117	1			1								1				1		1				
118	1			1								1	1	1	1	1		1				
119	1			1									1		1	1		1				
120	1											1				1		1				
121	1							1		1	1		1		1	1		1		1		
122	1									1		1	1		1	1		1				1
123												1				1						
124	1			1											1			1				
125	1			1						1		1	1		1	1		1				
126	1						1	1								1		1				
127	1	1						1		1		1	1			1		1				
128	1			1							1					1		1				
129	1			1			1			1			1			1		1				
130	1			1							1	1				1		1				
131	1					1		1		1		1				1		1				
132	1							1			1	1	1			1		1				
133	1							1				1				1		1				
134	1	1								1		1	1			1		1				
135	1			1							1	1				1		1				
136	1										1	1				1		1				
137	1			1	1						1	1				1		1				
138	1			1							1		1			1		1	1	1		
139	1			1				1			1	1	1			1		1				
140	1			1							1	1				1		1				
141	1	1									1	1						1				
142	1	1									1	1				1		1				1
143	1										1					1		1				
144	1											1			1	1		1				
145	1											1				1		1				
146	1										1					1		1				
147	1										1					1		1				
148	1										1					1		1				
149	1										1					1		1				
150	1										1					1		1				
151	1										1					1		1				
152	1										1					1		1				
153	1										1					1		1				
154	1										1					1		1				
155																		1				
156	1										1	1				1		1				
157	1										1	1				1		1				
158	1										1	1				1		1				
159	1										1					1		1				
160	1										1	1				1		1				
161	1										1					1	1	1				
162	1										1					1		1				
163	1										1					1	1	1				
164	1										1	1				1	1	1				
165	1										1	1				1	1	1				
166	1			1							1	1	1			1	1	1				
167	1										1	1	1			1	1	1				
168	1			1		1					1	1				1		1				
169	1			1							1	1	1			1	1	1				
Tota	60	7	0	17	5	3	4	14	0	8	44	36	19	5	13	39	4	54	3	3	2	2

No.1021 wet season
- a Rice
- b Other lowland crop
- c Other upland crop

No.1021 dry season
- a Rice
- b Maize
- c Soybean
- d Sweetpotato
- e Vegetable
- f Pasture
- g Others

No.1022 (Reason for selection of crop)
- a Familiar in Cultivation
- b For home use
- c Marketability
- d Others

No.1023 (rice varieties requested by farmers)
- a IRRI varieties
- b Local improved varieties
- c Traditional local varieties

Total	58	20	0	8	3	0	2	12	0	12	46	42	8	5	2	43	0	50	3	0	0	1
Total	60	7	0	17	5	3	4	14	0	8	44	36	19	3	13	39	4	54	3	3	2	2
A+B	118	27	0	25	8	3	6	26	0	20	90	78	27	8	15	102	4	104	6	3	2	3
	95.9	22	0	20.3	6.5	2.44	4.88	21.1	0	16.3	73.2	63.4	22	6.5	12.2	82.9	3.25	84.6	4.88	2.44	1.63	2.44
%																						

Table IV-3.5 (2/2) Farmer's Intention About Crop Production in Future, Tonle Bati

Code	1021(w)			No. 1021(d)							No.1022				No.1023			No.1031				
No.	a	b	c	a	b	c	d	e	f	g	a	b	c	d	a	b	c	a	b	c	d	e
1	1									1						1		1			1	
2	1									1		1				1		1				
3	1									1		1				1		1				
4	1			1								1				1		1				
5	1			1								1				1		1				
6	1									1						1		1				
7	1															1		1				
8	1	1					1											1				
9	1			1												1		1			1	
10	1									1						1		1				
11	1			1						1		1				1		1				
12	1			1								1				1		1				
13	1			1														1				
14	1			1								1				1		1				
15	1			1								1				1		1				
16	1			1								1				1		1				
17	1			1								1				1		1				
18	1					1						1				1		1				
19	1			1								1										
20	1			1				1				1				1		1				
21	1			1						1		1				1		1				
22	1			1												1		1				
23	1			1												1		1				
24	1			1							1	1				1		1				
25	1			1								1				1		1				
26	1			1												1		1				
27	1			1							1					1		1				
28	1			1								1				1		1				
29	1			1								1				1		1				
30	1			1								1				1		1				
31	1			1								1				1		1				
32	1			1								1				1		1				
33	1			1								1				1		1				
34	1			1								1				1		1				
35	1			1								1						1				
36	1	1		1											1	1						
37																						
38	1			1																		
39	1			1											1	1		1				
40																						
41																						
42																						
43	1			1											1	1		1				
Total	39	2	0	31	0	1	1	1	0	7	2	24	0	0	3	35	0	36	0	0	2	0
% 100	91	5	0	72	0	2	2	2	0	16	5	56	0	0	7	81	0	84	0	0	5	0

Note:

No.1021(w)

a Rice

b Other food crops than rice

c Other upland crops

No.1021(d)

a Rice

b Maize

c Soybean

d Sweetpotato

e Vegetable

f Pasture

g Other upland crops

No.1022(reason of selection)

a Familiar in cultivation

b For home use

c Marketability

d Others

No.1023(Varieties expected by farmers)

a IRRIvarieties

b Local improved varieties

c Traditional local varieties

No.1031(crops cultivated with fertilizers)

a Rice

b Maize

c Vegetables

d Beans

e Others

Table IV-3.6 (1/2) Seed, Fertilizers, Agro-chemical Use, Kandal Stung

Code	No.1032			No.1032 Part				No.1032	No.1041			No.1046	
No.	c	d	e	a	b	c	d	chemical	a	b	c	a	b
46							1		1				
47							1		1			1	
48							1			1			
49							1		1			1	1
50							1		1				
51							1			1		1	
52							1		1				1
53							1		1				1
54							1		1			1	
55										1		1	1
56							1		1				
57							1		1			1	
58							1					1	
59													
60							1		1			1	
61													
62							1			1		1	1
63							1		1			1	
64					1				1			1	1
65				1					1			1	1
66				1					1			1	1
67					1				1			1	1
68					1				1			1	
69					1		1		1			1	1
70					1				1			1	1
71			1				1		1			1	1
72			1				1		1			1	1
73			1				1		1			1	1
74			1				1		1			1	1
75			1				1		1			1	1
76			1				1					1	1
77							1					1	
78			1				1		1			1	1
79			1				1		1			1	1
80			1				1		1			1	1
81			1				1		1			1	1
82			1				1		1			1	1
83							1		1			1	1
84		1										1	1
85			1				1		1			1	1
86			1				1		1			1	1
87			1				1		1			1	1
88			1				1		1			1	1
89			1				1		1			1	1
90			1				1		1			1	1
91			1				1		1			1	1
92			1				1			1		1	1
93			1				1		1				1
94							1						
95							1						
96							1		1			1	1
97							1		1			1	1
98							1		1			1	
99							1	1					1
100							1	1				1	
101								1					
102							1		1			1	
103							1		1			1	
104							1		1			1	
105							1		1			1	
106							1		1			1	
107					1			1	1			1	
Total	0	1	20	2	6	0	50	4	46	5		49	36

Code	No.1032			No.1032 Fertilizer				No.1032	No.1041			No.1046	
No.	c	d	e	a	b	c	d	chemical	a	b	c	a	b
108						1			1			1	1
109						1			1			1	
110					1	1			1			1	1
111						1			1			1	
112						1			1			1	
113						1			1			1	1
114						1			1			1	
115									1			1	
116						1			1				
117					1	1			1			1	
118						1		1	1			1	
119						1		1	1				
120						1		1	1			1	
121		1				1		1	1				1
122						1		1		1		1	1
123						1		1		1			
124						1		1		1		1	1
125						1		1					1
126				1					1			1	
127					1	1			1			1	
128						1			1				1
129						1			1			1	
130					1	1			1			1	
131									1				
132					1				1				1
133					1				1			1	
134					1				1				
135				1					1				
136						1							
137					1	1			1				
138					1	1			1				
139						1			1			1	
140						1		1	1			1	
141						1							
142						1			1			1	
143						1			1			1	
144						1		1	1				
145						1						1	
146						1			1				1
147						1			1			1	1
148						1			1			1	
149						1						1	
150						1			1			1	
151						1			1			1	1
152						1			1			1	1
153						1			1				
154						1			1			1	
155						1							
156						1			1			1	
157						1			1			1	
158						1			1			1	1
159						1		1	1			1	
160						1			1				1
161									1			1	
162									1				
163						1			1			1	1
164						1			1			1	
165						1			1			1	
166						1			1			1	
167									1				
168													
169									1			1	
	0	1	0	2	9	50	0	11	52	3		40	16

Total A	0	1	20	2	6	0	50	4	46	5		49	36
Total B	0	1	0	2	9	50	0	11	52	3		40	16
A+B	0	2	20	4	15	50	50	15	98	8	0	89	52
%	0%	1%	12%	2%	9%	30%	30%	9%	60%	5%	0%	54%	32%

Note Total sample is 164

No. 1032 (Seed, Fertilizer, Agro-chemicals and Feed)

purchased place at:

a Agricultural Development Office* Cross out

b District Agricultural Office* Cross out

c Store of Khum Office

d Local market

e Other

No. 1041(Do you exchange labour with other farmer?

a Yes

b No

c If"yes" how many days?

No. 1064 (Do you pay in cash or in kind?

a Cash

b in kind

Table IV-3.6 (2/2) Seed, Fertilizers, Agro-chemical Use, Tonle Bati

Code	No.1032 Seed					NO.1032 Ferti					No. 1032 Chemi					No.1032 Feed					No.1041			NO.1046	
No.	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	a	b
1				1					1					1					1		1		50		
2				1					1					1					1		1		50		
3									1										1		1		40		
4									1										1		1		30	1	
5									1												1		60	1	
6									1												1		45		
7									1													1		1	1
8									1					1					1		1		45		
9				1					1													1			
10				1					1													1			
11									1										1		1		110		
12									1												1		60	1	
13									1										1		1		40		
14									1										1		1		75		
15									1										1		1		60		
16									1										1		1		60		
17									1												1		30	1	
18									1												1		60	1	
19									1												1		60	1	1
20									1												1		30		
21									1												1		60		
22									1												1		30		
23									1										1		1		75		
24									1										1		1		70		
25									1												1		50		
26									1					1							1		50	1	
27									1												1		60	1	1
28									1										1		1		52		
29									1										1		1		50		1
30									1												1		100		
31									1										1		1		50	1	
32									1										1		1		70		1
33									1												1		50		
34									1										1		1		40	1	
35									1												1		60		
36																						1			
37																						1			
38																						1			
39																						1			
40									1													1			
41																						1			
42																						1			
43																						1			
Total	0	0	0	4	0	0	0	0	36	0	0	0	0	4	0	0	0	0	17	0	32	11	32	11	5
%	0%	0%	0%	9%	0%	0%	0%	0%	84%	0%	0%	0%	0%	9%	0%	0%	0%	0%	40%	0%	74%	26%	74%	26%	12%

Note:

No.1032 (Seed, Fertilizer,Agro-chemical,Feed)

Purchased place of:

a Agricultural Development Office
b District Agricultural Offices
c Sire of Khum Offices
d Local market
e Others

No.1041(Do you exchange labour with other farmer?)

a Yes
b No
c If"yes" how many days?

No.1046 (Do you pay in cash or in kind?)

a Cash
b In Kind

Table IV-3.7 (1/2) Promotion of Livestock and Expectation for Agricultural Extension, Kandal Stung

Code	N.1051		No.1052				No.1053					No.1061						
No.	a	b	a	b	c	d	a	b	c	d	e	a	b	c	d	e	f	g
46			1	1					1									
47		1							1			1			1		1	1
48		1							1			1			1		1	1
49		1							1			1			1	1	1	1
50	1	1							1			1				1	1	1
51			1						1			1			1	1	1	1
52	1		1	1	1				1			1			1			
53	1		1	1	1		1	1				1			1		1	1
54		1	1	1	1				1			1			1		1	1
55		1							1			1			1		1	1
56		1							1			1					1	1
57	1								1			1			1	1	1	
58	1								1			1			1	1		
59															1			1
60																		1
61	1		1	1	1	1										1	1	
62		1									1	1		1		1		
63	1		1	1	1	1	1	1				1		1	1	1		1
64	1		1	1	1	1	1	1				1	1	1	1	1	1	1
65	1																	
66	1		1	1	1							1	1	1	1	1	1	1
67	1		1	1	1		1					1	1	1	1	1	1	
68		1					1	1				1		1	1	1	1	
69	1		1	1	1	1						1		1	1	1	1	1
70	1		1	1								1		1	1	1	1	
71	1		1	1			1	1				1			1	1	1	1
72	1		1	1			1	1				1		1		1	1	1
73	1		1	1	1	1	1	1	1			1			1	1	1	1
74	1		1	1	1	1	1	1	1			1	1		1	1	1	1
75	1		1	1			1	1				1			1	1	1	1
76	1		1	1			1	1				1			1	1	1	1
77	1		1	1	1		1	1	1			1					1	1
78	1		1	1			1	1				1			1	1	1	1
79	1		1	1	1		1	1				1			1	1	1	1
80	1		1	1			1	1				1			1	1	1	1
81	1		1	1	1		1	1				1			1	1	1	1
82	1		1	1	1		1	1				1			1	1	1	1
83	1		1	1			1	1					1		1	1	1	1
84	1		1	1	1			1				1					1	
85	1		1	1	1	1		1				1				1	1	
86	1		1	1			1	1				1			1	1	1	1
87	1		1	1			1	1				1			1	1	1	1
88	1		1	1			1	1				1			1	1	1	1
89	1		1	1			1	1				1			1	1	1	1
90	1		1	1			1	1				1			1	1	1	1
91	1			1		1	1	1	1			1			1	1	1	1
92	1			1	1		1	1	1			1				1	1	1
93	1							1				1			1		1	1
94	1			1			1		1	1						1	1	1
95	1			1		1		1				1					1	1
96		1					1	1	1	1	1	1	1	1	1		1	1
97	1		1	1	1	1		1				1			1	1	1	1
98	1		1	1	1	1						1			1	1	1	1
99	1		1	1	1	1						1			1	1	1	1
100	1			1	1	1		1		1		1			1	1	1	1
101	1		1	1	1	1												1
102	1		1	1	1	1						1					1	
103	1		1	1	1	1						1		1		1		
104	1		1	1	1	1						1		1	1		1	
105	1		1	1	1	1						1			1		1	
106	1		1	1	1	1			1		1	1		1	1			
107	1		1	1	1	1						1		1	1		1	
Total	49	10	42	46	29	20	27	44	7	4	2	54	6	14	45	40	51	44

Code	N.1051		No. 1052				No. 1053					No. 1061						
No.	a	b	a	b	c	d	a	b	c	d	e	a	b	c	d	e	f	g
108	1		1	1				1				1		1	1	1	1	1
109	1		1	1	1	1						1	1	1	1			1
110	1		1	1	1	1	1	1	1		1	1		1	1	1	1	1
111	1		1	1	1	1						1		1	1		1	
112	1		1	1	1	1						1		1	1		1	
113	1		1	1	1	1		1				1	1	1	1	1	1	1
114	1		1	1	1	1						1		1	1		1	1
115	1		1	1	1	1						1		1	1		1	
116	1		1	1	1	1						1			1		1	
117	1		1	1	1			1				1			1		1	
118	1		1	1	1	1						1			1	1	1	1
119	1		1	1	1	1						1			1	1	1	1
120	1		1	1	1	1						1			1	1	1	1
121	1		1	1	1	1						1		1	1	1	1	1
122	1		1	1	1	1	1	1			1	1		1	1	1	1	1
123			1	1	1	1	1	1			1	1		1	1	1	1	1
124	1		1	1	1	1	1	1			1	1		1	1	1	1	1
125	1		1	1	1	1	1	1	1	1	1	1			1	1	1	1
126	1		1	1	1	1		1										
127	1		1	1	1													
128	1		1		1							1		1	1		1	
129	1		1	1	1							1		1	1			
130		1	1					1				1	1	1	1	1	1	1
131	1		1	1								1		1		1	1	1
132	1		1	1	1	1												
133	1		1	1	1	1						1		1	1			
134												1		1	1			
135	1		1	1	1			1				1	1	1	1	1	1	1
136	1		1	1	1					1		1			1		1	
137	1									1		1		1			1	
138	1		1	1	1							1		1	1		1	
139	1											1			1		1	
140	1		1	1	1							1			1		1	
141	1		1					1			1	1	1	1	1	1	1	1
142	1		1					1			1	1	1	1	1	1	1	1
143	1		1	1	1	1	1	1			1	1			1	1	1	1
144	1		1	1	1	1	1	1			1	1			1	1	1	1
145	1		1					1			1	1	1	1	1	1		1
146	1		1	1	1	1		1				1	1				1	
147	1		1	1	1	1		1				1	1				1	
148	1		1	1	1	1						1	1	1			1	
149	1		1	1	1	1						1	1				1	
150	1		1	1	1	1						1	1				1	
151	1		1	1	1	1		1				1	1				1	
152	1		1	1	1	1		1				1			1		1	
153	1		1	1	1	1		1				1			1		1	
154	1		1	1	1	1		1				1			1			
155																		
156	1		1	1	1			1			1	1			1	1	1	1
157	1		1	1	1	1					1	1			1	1	1	1
158	1		1	1	1	1	1	1			1	1	1		1	1	1	1
159	1		1	1		1						1			1			
160	1		1	1	1		1	1				1		1	1	1	1	1
161	1		1	1	1	1		1				1	1			1	1	
162	1		1	1	1	1		1				1	1			1	1	
163	1		1	1	1	1		1				1	1			1	1	
164	1		1	1	1			1				1	1			1	1	
165	1		1	1	1	1	1	1			1	1	1		1	1	1	1
166	1		1	1	1			1				1		1	1			
167	1		1	1	1			1				1			1			
168	1		1	1	1			1				1			1	1	1	
169	1		1	1	1	1		1				1			1	1	1	1
Total	58	1	58	53	51	38	10	34	2	3	14	58	19	27	46	30	50	26

Note:

No.1051(Farmer who expected to increase more livestock)
- a Yes
- b No

No. 1052 (kind of livestock expected to increasefor future)
- a Cow
- b Pig
- c Chicken
- d Duck

No. 1053 (Difficulty)
- a Disease control
- b Lack of fund
- c Lack of animal feed
- d Shortage of familiy labour
- e Others

No.1061 (expected extension activities)
- a Rice cultivation techniques
- b Upland crop cultivation techniques
- c Vegetable cultivation techniques
- d Livestock raising techniques
- e Input supply system
- f Provision of rural credit
- g Guidance for home life improvement

Sub total	49	10	42	46	29	20	24	44	7	4	2	54	6	14	45	40	51	44
Sub total	58	1	58	53	51	38	10	34	2	3	14	58	19	27	46	30	50	26
Total	107	11	100	99	80	58	34	78	9	7	16	112	25	41	91	70	101	70
Percentage(%)	86.99	8.94	81.3	80	65	47	28	63	7.3	5.7	13	91.1	20	33	74	57	82.1	

Table IV-3.7 (2/2) Promotion of Livestock and Expectation for Agricultural Extension, Tonle Bati

Code	N.1051		No. 1052 Livestock				No.1053 Difficulty					No.1061 Expected Extension						
No.	a	b	a	b	c	d	a	b	c	d	e	a	b	c	d	e	f	g
1	1		1		1		1	1	1			1	1	1	1	1	1	1
2	1			1				1				1	1		1	1	1	1
3	1		1		1	1	1	1				1			1		1	
4	1		1	1	1			1				1			1			1
5	1		1	1	1			1				1	1	1	1			
6																		
7	1			1	1				1	1		1			1		1	1
8	1		1	1	1		1		1		1							
9																		
10																		
11	1		1	1	1							1			1		1	
12	1	1	1	1								1			1			
13	1		1	1	1							1			1			
14	1		1	1	1							1			1			
15		1			1							1			1		1	1
16	1		1	1								1			1			
17	1		1									1			1			
18	1		1	1								1			1		1	
19	1		1	1								1			1			
20	1		1	1						1		1	1	1	1			
21	1		1									1			1		1	
22	1		1	1								1			1			
23	1		1	1								1			1			
24	1		1	1								1			1			
25	1		1	1	1							1			1			
26	1		1	1	1							1			1			1
27	1		1	1								1			1		1	
28	1		1	1								1			1		1	
29	1		1	1								1			1		1	
30	1			1	1				1			1			1		1	
31	1			1								1			1			
32	1			1	1							1			1			
33	1			1	1							1			1			
34	1			1								1			1			
35												1			1		1	
36												1			1			
37																		
38																		
39		1		1	1	1												
40																		
41																		
42																		
43																		
Total	30	3	23	27	16	2	3	6	3	2	1	32	4	3	32	2	13	6

Note:

No. 1051(do you expected to increase more livestocks?)

a Yes

b No

No. 1052 (what Kind of livestok expected to increase for future)

a Cow

b Pigs

c Chicken

d Duck

No. 1053 (problem)

a Disease control

b Lack of fund

c Lack of animal feed

d Shortage of familiy labour

e Other

No. 1016(expected Extension cervices)

a Rice cultivation techniques

b Upland crop cultivation techniques

c Vegetable cultivation techniques

d Livestock raising techniques

e Input supply system

f Provisition of rural credit

g Guidance for home life improvement

Table IV-3.8 (1/4) Quantity and Unit Prices of Farm Inputs Applied, Kandal Stung PA Early Rice

Code No.	Planted area	Seed kg/ area	Seed kg/ha	Seed Riel/ kg	Urea kg/ area	Urea kgha	Urea Riel/ kg	DAP kg	DAP Riel/ kg/ha	DAP Riel/ kg	16-20-0 kg	16-20-0 kg/ha	16-20-0 Riel/ kg	Pesticidess Litter	Pesticidess litter /ha	Pesticidess Riel/ littre
99	0.2	17	113	324	0	0		0	0		0	0		0.0	0.0	
119	0.5	51	113	324	20	44	540	0	0		0	0		0.0	0.0	
121	0.6	51	89	324	0	0		0	0		0	0		0.0	0.0	
131	0.4	70	167	300	25	60	500	25	60	550	0	0		0.0	0.0	
166	0.7	36	51	607	20	29	500	0	0		20	29	540	0.5	0.7	25
167	0.2	20	100	350	20	100	500	0	0		20	100	550	0.0	0.0	
168	0.3	40	133	525	50	167	440	0	0		50	167	540	0.3	1.0	25
169	0.7	50	71	305	50	71	460	0	0		30	43	56	1.5	2.1	25
Number of sample																
8	8	8	8	8	8	8	6	8	8	1	8	8	4	8	8	3
Total	3.5	335			185			25			120			2.3		
Average	0.4		96			53			7			34			0.7	

Number of sample:	124	households	
Number of cultivater of eraly rice:	8	households	
Total cultivated area:	3.5	ha	
Average cultivated area/household:	0.4	ha	
Average inputs applied:			N P K
Seed	96	kg/ha	
Urea	53	kg/ha	22 0 0
DAP	7	kg/ha	1 4 0
16:20:0	34	kg/ha	6 7 0
		kg/ha	29 10 0

Source: Farm household survey conducted by JICA survey team,1994

Table IV-3.8 (2/4) Quantity and Unit Prices of Farm Inputs Applied, Kandal Stung PA Late Rice

Code No.	Planted area (ha)	Seed (kg/ha)	Seed area (ha)	Seed (Riel/kg)	Urea (kg/ha)	Urea (Riel/kg)	DAP (kg/ha)	DAP (Riel/kg)	16-20-0 (kg/ha)	16-20-0 (Riel/kg)
46										
47										
48	0.5	60	0.5	300	25	500	25	600	0	0
49										
50										
51	0.3	30	0.3	300	0	0	30	800	0	0
52										
53										
54										
55	0.4	30	0.4	300	0	0	0	0	0	0
56										
57										
58										
59										
60										
61										
62										
63										
64										
65										
66										
67										
68										
69										
70										
71										
72										
73										
74										
75										
76										
77	0.6	80	0.6	300	50	500	0	0	0	0
78	1.4				50	500	0	0	100	600
79									71	
80										
81										
82	1.5	120	1.5		50	500	50	600	0	0
83							33			
84										
85										
86										
87	1.1				50	500	50	600	0	0
88					46		46			
89										
90										
91										
92										
93										
94										
95										
96										
97										
98	0.5	50	0.5	300	20	540	0	0	20	660
99					40				40	
100										
101										
102										
103										
104										
105										
106										
107										

Code No.	Planted area (ha)	Seed (kg/ha)	Seed area (ha)	Seed (Riel/kg)	Urea (kg/ha)	Urea (Riel/kg)	DAP (kg/ha)	DAP (Riel/kg)	16-20-0 (kg/ha)	16-20-0 (Riel/kg)
108										
109										
110	1.0	150	1.0	300	50	500	50	500	0	0
111		150			50		50			
112										
113										
114										
115										
116	0.7	55	0.7	300	30	600	30	660	0	0
117	0.1	7	0.1	300	7	660	0	0	0	0
118					43		43			
119	0.3	34	0.3	324	10	540	0	0	0	0
120		113			33		0		0	
121	0.4	51	0.4	324	0	0	0	0	0	0
122		128			0		0		0	
123										
124										
125	0.3	45	0.3	324	20	540	0		0	0
126	0.5	150	0.5	300	67	500	0	550	0	0
127		100			50		50			
128					111		111			
129										
130										
131										
132	0.8	120	0.8	300	50	500	50	550	0	0
133	0.2	150	0.2	300	63	500	63	550	0	0
134		30			30		20			
135		125			125		83			
136										
137	0.3	23	0.3	300	25	220	25	450	0	0
138	0.4	77	0.4	300	83		83		0	0
139		25			0		0		0	
140	0.4	63	0.4	300	0		0		0	
141	0.5	30	0.4	300	10	250	0		15	43
142		86			29		0			270
143	0.3	50	0.5	290	0		50	526	0	0
144		100			0		100			
145	0.8	40	0.3	290	25	290	25	300	0	0
146	0.0	133			83		83			
147	0.5	75	0.8	295	50	396	50	526	0	0
148		94			63		63			
149										
150										
151										
152										
153										
154										
155										
156										
157	0.2	20	0.2	290	0		0		0	0
158	1.2	80	1.2		50	396	0		0	0
159		67			42		0			
160										
161										
162	0.8	90	0.8	300	100	500	50	600	0	0
163	1.3	125	1.3	300	133	500	67	600	0	0
164		100			100		150			
165	1.0	90	1.0		80	500	120	593	0	0
166		90			50		50			
167					50	500	50	600	0	0
168										
169										

No. of sample														
124	30	27	27	27	24	29	29	24	29	29	20	29	29	3
Total	18	1,615		16		952			805			135		
Aver	0.6		89	0.6			53			44			7	

			N	P	K
Number of sample:	124	household			
Number of cultivater:	30	(239 household			
Total cultivated area:	18	ha			
Average cultivated area/household:	0.6	ha			
Inputs applied:					
Seed	89	kg/ha			
Urea	53	kg/ha	22	0	0
DAP	44	kg/ha	9	22	0
16:20:0	7	kg/ha	1	1	0
		kg/ha	32	24	0

Table IV-3.8 (3/4) Quantity and Unit Prices of Farm Inputs Applied, Kandal Stung PA Mid Rice

Code No.	Planted area	Seed kg	Seed kg/ha	Seed area* ha	Seed Riel/kg	Urea kg	Urea kg/ha	Urea Riel/kg	DAP kg	DAP kg/ha	DAP Riel/kg	16-20-0 kg	16-20-0 kg/ha	16-20-0 Riel/kg
46	0.5	60	120	0.5	300	0	0		25	50	800	0	0	
47	1.3	150	119	1.3	300	50	40	500	50	40	600	0	0	
48	0.8	90	113	0.8	300	50	63	500	50	63	600	0	0	
49	0.7	90	129	0.7	300	50	71	500	50	71	600	0	0	
50	0.5	60	128	0.5	300	25	53	500	50	106	600	0	0	
51	0.2					0	0		30	130	800	0	0	
52	0.8					25	31	600	25	31	800	0	0	
53	1.0	80	82	1.0	300	10	10	500	10	10	700	0	0	
54	0.3	30	88	0.3	300	10	29	500	10	29	600	0	0	
55	0.4	45	113	0.4	300	0	0		0	0		0	0	
56	0.6	75	123	0.6	300	25	41	500	50	82	600	0	0	
57	0.5	60	120	0.5	300	50	100	500	50	100	600	0	0	
58	0.7	90	129	0.7	300	50	71	500	50	71	600	0	0	
59														
60	0.8	90	107	0.8	300	25	30	500	50	60	600	0	0	
61														
62	0.3	30	100	0.3	300	20	67	500	25	83	550	0	0	
63	1.0	90	90	1.0	300	100	100	500	50	50	550	0	0	
64	0.6	61	100	0.6	300	50	82	500	50	82	550	0	0	
65	0.6	50	83	0.6	300	50	83	500	25	42	550	0	0	
66	1.0	90	90	1.0	300	50	50	500	100	100	550	0	0	
67	1.0	90	90	1.0	300	50	50	500	100	100	550	0	0	
68	0.7	70	100	0.7	300	50	71	500	50	71	550	0	0	
69	1.3	100	77	1.3	300	0	0		100	77	550	0	0	
70	1.0	90	90	1.0	300	0	0		100	100	550	0	0	
71	1.0	150	150	1.0	500	0	0		0	0		0	0	
72	0.9	120	133	0.9	300	25	28	500	0	0		0	0	
73	0.7					100	154	500	0	0		0	0	
74	0.8	100	133	0.8	300	100	133	500	50	67	600	0	0	
75	0.8	100	125	0.8	300	50	63	500	0	0		50	63	600
76	0.5	75	150	0.5	300	50	100	500	100	200	600	0	0	
77	0.6	80	143	0.6	300	500	893	500	0	0		0	0	
78														
79	1.1	300	278	1.1	300	100	93	500	50	46	600	0	0	
80	0.5	75	150	0.5	300	25	50	500	25	50	600	0	0	
81	0.6	60	100	0.6	300	25	42	500	25	42	600	0	0	
82	1.5	120	80	1.5	300	50	33	500	50	33	600	0	0	
83	0.8	90	120	0.8	300	25	33	500	25	33	600	0	0	
84	0.3	45	150	0.3	300	25	83	500	0	0	0	25	83	280
85	0.4	35	92	0.4	300	5	13	500	0	0	0	10	26	290
86	0.5					50	100	500	0	0	0	0	0	
87														
88	0.5	60	120	0.5	300	30	60	500	30	60	600	0	0	
89	0.8	180	225	0.8	300	50	63	500	50	63	600	0	0	
90	0.5	60	120	0.5	300	25	50	500	25	50	600	0	0	
91	1.4	300	214	1.4	300	75	54	500	0	0		0	0	
92	2.4	100	43	2.4	300	400	170	500	400	170	600	0	0	
93														
94														
95	0.4	45	129	0.4	300	50	143	500	0	0		50	143	600
96	0.7	80	114	0.7	323	50	71	540	0	0				
97	1.0	119	119	1.0	300	75	75	540	0	0		50	50	660
98														
99	0.6	119	216	0.6	324	35	64	540	0	0		35	64	660
100	0.3	34	113	0.3	324	25	83	540	0	0		25	83	660
101														
102	0.2	45	225	0.2	300	50	250	450	0	0		25	125	600
103	0.6	75	125	0.6	300	50	83	450	0	0		50	83	640
104	0.6	90	150	0.6	300	50	83	400	0	0		50	83	600
105	0.3	60	231	0.3	300	50	192	450	0	0		0	0	
106	0.3	45	141	0.3	300	50	156	500	50	156	550	0	0	
107	0.3	65	203	0.3	300	25	78	500	40	125	550	0	0	
108	0.8	60	72	0.8	300	100	120	500	100	120	550	0	0	
109	0.3	60	188	0.3	300	25	78	500	25	78	550	0	0	
110	0.7	105	150	0.7	300	25	36	500	25	36	550	0	0	
111	0.6	75	117	0.6	300	25	39	500	25	39	500	0	0	
112	0.3	30	94	0.3	300	25	78	500	25	78	550	0	0	
113	0.3	45	136	0.3	300	15	45	500	25	76	550	0	0	
114	0.4	45	113	0.4	300	25	63	500	25	63	550	0	0	
115	1.5	70	47	1.5	300	25	17	500	75	50	550	0	0	
116	0.3	25	83	0.3	300	20	67	600	0	0		20	67	
117														
118	0.5	36	75	0.5	300	20	42	540	0	0		30	63	
119	0.6	68	108	0.6	324	20	32	540	0	0		0	0	
120	0.3	34	117	0.3	324	15	52	540	0	0		15	52	
121	0.8	238	283	0.8	324	34	40	540	0	0		34	40	
122	1.4	110	79	1.4	338	100	72	540	50	36	720	50	36	
123														
124	1.4					50	36	550	0	0		50	36	
125	0.5					30	60	540	0	0		50	100	
126	0.5													
127	0.5	60	133	0.5	300	50	111	500	50	111	550			
128	0.2	20	100	0.2	300	25	125	500	25	125	550			
129	0.2	30	200	0.2	300	5	33	500	5	33	550			
130	0.5	60	133	0.5	300	10	22	500	20	44	550			
131	1.0	110	110	1.0	300	50	50	500	50	50	550			
132	0.8	120	160	0.8	300	50	67	500	50	67	550			
133														
134	0.8	90	120	0.8	300	50	67	500	25	33	550	0	0	
135	0.8	100	122	0.8	300	50	61	500	50	61	550	0	0	
136	1.6	90	56	1.6	300	0	0		50	31	250	50	31	
137	0.3	23	92	0.3	300	75	300	220	25	100	450	0	0	
138	1.4	125	89	1.4	300	50	36	180	0	0		50	36	
139	0.9	80	89	0.9	300	25	28	250	0	0		25	28	
140														
141	0.5	50	100	0.5	300	50	100	526	0	0		0	0	
142	0.3	75	250	0.3	295	50	167	396	50	167	526	0	0	
143	0.4	90	225	0.4	300	25	63	290	25	63	300	0	0	
144	1.2	90	75	1.2	295	100	83	396	50	42	526	0	0	
145														
146	0.8	90	113	0.8	300	100	125	500	100	125	600	0	0	
147														
148	1.0	90	90	1.0	300	100	100	500	0	0		100	100	
149	0.7	180	257	0.7	300	50	71	460	50	71	560	0	0	
150	2.0	300	150	2.0	300	100	50	500	0	0		100	50	
151	0.5	90	180	0.5	300	50	100	420	50	100	560	0	0	
152	0.7	45	64	0.7	300	50	71	560	50	71	600	0	0	
153	1.2	150	125	1.2	300	100	83	600	0	0	0	50	42	
154	0.5	90	180	0.5	300	50	100	580	0	0	0	0	0	
155														
156														
157	0.8	30	40	0.8	295	0	0		0	0	0	0	0	
158														
159	0.8	120	160	0.8	300	0	0		0	0	0			
160	1.6	90	56	1.6	300	0	0		0	0	0	100	63	
161	1.3	90	72	1.3	300	50	40	500	0	0	0	0	0	
162														
163														
164	0.8	90	120	0.8	295	50	67	500	0	0		0	0	
165														
166	1.0	54	54	1.0	510	30	30	370	0	0		30	30	
167	0.7	80	114	0.7	300	30	43	500	0	0		30	43	550
168														
169	1.1	100	95	1.1	305	100	95	460	0	0		70	67	
No. of sample														
124	103	96	96	96	96	102	102	92	102	102	70	94	94	11
Total	76	8,321		71.3		5,039			3,120			1,224		
Aver.	0.7		117	0.7			66			41			16	

Number of sample :	123	households	
Number of household cultivate mid rice:	103 (84%)	households	
Total cultivated area:	76	ha(77.7% of total rice field surveyd)	
Average cultivated area/household:	0.7	ha	

Inputs appplied:			N	P	K
Seed	117	kg/ha			
Urea	66	kg/ha	28	0	0
DAP	41	kg/ha	8	21	0
16:20:0	16	kg/ha	3	3	0
		kg/ha	39	24	0

Source: Farm household survey conducted by JICA survey team,1994

Table IV-3.8 (4/4) Quantity and Unit Prices of Farm Inputs Applied, Tonle Bati PA Mid Rice

Code No.	Planted area (ha)	Seed (kg)	Seed (kg /ha)	Seed area ha	Seed (Riel /kg)	Urea (kg)	Urea (kg /ha)	Urea (Riel /kg)	DAP (kg)	DAP (kg /ha)	DAP (Riel /kg)	16-20-0 (kg)	16-20-0 (kg /ha)	16-20-0 (Riel /kg)
1														
2	0.7	48	69	0.7	417	100	143	460	0	0		0	0	
3	0.5	48	96	0.5	375	10	20	400	25	50		0	0	
4	0.7	60	86	0.7	500	10	14	500	0	0		0	0	
5	1.0	144	144	1.0	375	200	200	500	0	0		0	0	
6	1.0	45	45	1.0	356	0	0		30	30		0	0	
7	0.1	24	240	0.1	375	0	0		0	0		0	0	
8	1.0	36	36	1.0	375	100	100	520	0	0		0	0	
9	0.4	38	95	0.4	474	0	0		0	0		0	0	
10	0.4	36	103	0.4	375	0	0		0	0		0	0	
11	1.5	96	64	1.5	417	50	33	400	75	50		0	0	
12	0.7	72	103	0.7	400	50	71	400	50	71	520	0	0	
13	1.0	60	60	1.0	400	100	100	400	50	50	520	0	0	
14	1.0	120	120	1.0	400	100	100	400	100	100	520	0	0	
15	1.0	60	60	1.0	400	50	50	400	50	50	520	0	0	
16	1.5	120	80	1.5	400	100	67	400	100	67	520	0	0	
17	0.4	36	90	0.4	400	15	38	400	30	75	520	0	0	
18	1.5	100	67	1.5	400	100	67	400	100	67	520	0	0	
19	1.0	60	60	1.0	400	50	50	400	50	50	520	0	0	
20	1.0	60	60	1.0	400	50	50	400	100	100	520	0	0	
21	1.0	60	60	1.0	400	100	100	400	100	100	520	0	0	
22	1.5	120	80	1.5	400	50	33	400	100	67	520	0	0	
23	1.8	120	67	1.8	400	100	56	400	100	56	520	0	0	
24	1.5	120	80	1.5	400	50	33	400	50	33	520	0	0	
25	1.0	120	120	1.0	400	0	0		0	0	520	0	0	
26	1.0	60	60	1.0	400	100	100	400	100	100	520	0	0	
27	0.5	40	80	0.5	400	10	20	400	10	20	520	0	0	
28	1.0	72	72	1.0	400	100	100	400	100	100	520	0	0	
29	1.0	60	60	1.0	400	50	50	400	100	100	520	0	0	
30	1.7	120	73	1.7	417	50	30	400	50	30	520	0	0	
31	0.8	60	80	0.8	400	50	67	400	0	0		0	0	
32	1.5	120	80	1.5	400	100	67	400	50	33		0	0	
33	0.8	72	96	0.8	400	10	13	400	0	0	520	100	133	600
34	0.8	120	150	0.8	400	50	63	400	0	0		0	0	
35	0.8	120	160	0.8	400	50	67	400	100	133	520	0	0	
36	1.2	95	79	1.2	350	50	42	400	0	0		50	42	520
37														
38	1.3	95	73	1.3	350	0	0		0	0		0	0	
39	1.0	72	72	1.0	350	50	50	400	0	0		50	50	520
40														
41														
42	1.4	120	86	1.4		0	0		0	0		0	0	
43														
44														
45														
Count	38	38				38			38			38		
Total	37.1	2,981		37		1,955			1,620			200		

			N	P	K
Number of effective sample:	38	household			
Total cultivated area:	37.8	ha			
Average cultivated area/household:	1.0	ha			
Average inputs applied:					
Seed	80	kg/ha			
Urea	53	kg/ha	22	0	0
DAP	44	kg/ha	9	22	0
16:20:0	5	kg/ha	1	1	0
		kg/ha	32	23	0

Surce: Farm household survey conducted by JICA survey team,1994

Table IV-3.9 (1/2) Number of Livestock per Farm Household, Kandal Stung

Code	Cattle					Pigs			Chicken	Duck
No.	Cow	Oxen	Calf	Cow+Ox	Total	Fatte.	Rear	Total		
46									17	
47										
48		2			2		1	1	4	
49									5	
50									5	
51										
52		2		2	4					
53	1	2		3	6		2	2	15	
54									18	
55									6	
56						1		1		
57									25	
58							2	2	3	
59							1	1	1	
60									8	
61										
62										
63	2	2		4	8		1	1	17	
64			1		1				11	
65	1		2	1	4				5	
66	1			1	2				10	
67	1		2	1	4				15	
68			1		1					80
69		2		2	4				35	
70		2		2	4	2		2	3	
71		2		2	4					
72	2	2		4	8	2		2		
73			3		3	1		1		
74			3		3	1		1		
75										
76						1		1		
77			1		1	1		1		
78	2	2		4	8	1		1		
79										
80						1		1		
81										
82		2		2	4	2		2		
83		1			1	3		3	3	
84										
85										
86	1	4		5	10					
87	1		2	1	4					
88	2		2	2	6					
89	1	1		2	4	2		2		
90	1	1		2	4					
91	1	2	1	3	7					
92	3	4	2	7	16				3	
93										
94										
95		1		1	2				5	
96						2		2	5	
97						2		2	2	
98									6	
99	2	2		4	8	4		4	6	
100						1		1	1	
101									2	
102									20	
103			3		3					
104									20	
105									5	
106										
107									6	
Total A	22	36	23	55	136	27	7	34	287	80

Code	Cattle					Pigs			Chicken	Duck
No.	Cow	Oxen	Calf	Cow+ox	Total	Fatte..	Rear	Total		
108		2		2	2			0		
109				0	2			0	36	
110		2		2	2			0		
111	1			1	1			0		
112				0	0			0	1	
113	1		1	1	2	1		1		
114				0	0			0		
115				0	2	5		5	10	
116		2		2	2			0		
117				0	0	1		1		
118				0	2		3	3	3	
119		2		2	2	1		1		
120				0	2	1	2	3	2	
121	1	2		3	3	3	65	68		10
122	1			1	1	2		2	65	5
123	1		1	1	2	1	3	4		
124	1		1	1	4		20	20	3	
125		2		2	2	1	25	26	20	
126				0	0			0	25	
127				0	0	2	9	11		
128				0	0		5	5	9	
129				0	1		1	1	5	
130		1		1	2			0	1	
131	2	1		3	6		3	3		
132		3		3	3			0	3	
133				0	2			0		
134		2		2	4	1	1	2	1	
135		2		2	4	2	2	4	2	
136	1	2		3	5			0		
137	2	2		4	6	2	30	32	30	
138	2	2		4	4	3	4	7	4	
139			1	0	1	1		1		
140			2	0	6	1	5	6	5	
141		4		4	7		2	2	2	
142		3		3	3	1	3	4	3	
143	1			1	3		5	5	5	
144		2		2	5			0		
145		3		3	4		4	4	4	
146	1	1	1	2	3			0		
147				0	1			0		
148		1	1	1	2			0		
149				0	2			0		
150		2		2	2			0		
151				0	0	1		1		
152				0	3			0		
153		3		3	3	1	3	4	3	
154				0	0			0		
155				0	0			0		
156				0	0			0		
157				0	2			0		
158	1	2	1	3	4		6	6	6	
159	1		1	1	4			0		
160		2		2	2	1	5	6	5	
161	1		1	1	4	2		2		
162		2		2	2			0		
163				0	1		10	10	10	
164	2	1		3	3	2	2	4	2	
165				0						
Total B	20	53	11	73	53	36	218	254	265	15
Total A	22	36	23	55	136	27	7	34	287	80
A+B	42	89	34	128	189	63	225	288	552	95
Ave*	0.4	0.7	0.3	1.1	1.6	0.5	1.9	2.4	4.6	0.8

Source: Farm household suevey conducted by JICA survey team, 1994

Table IV-3.9 (2/2) Number of Livestock per Farm Household, Tonle Bati

Code	Cattle					Pigs			Chickens	Duck
No.	Cow	Oxen	Culf	Cow+Ox	Total	Fatt	Rear	Total		
1	3	6		9	9	7		7		
2		3		3	3			0	4	
3	1	1		2	2	3		3		
4	2	1		3	3	1		1		
5	1	1		2	2			0		
6				0	0	1		1		
7				0	0	1		1		
8	1	1		2	2	1		1		
9		2		2	2	1		1		
10	2	1		3	3	1		1		
11		2		2	2		4	4	4	
12		2		2	2			0		
13	1	2		3	3		2	2	3	
14			3	0	3		1	1		
15	2			2	2		1	1		
16	1	2		3	3		2	2	2	
17	1			1	1			0	2	
18			2	0	2			0	4	
19			1	0	1			0		
20			3	0	3			0		
21	2	1		3	3			0	5	
22	1	1	2	2	4			0	10	
23	1		2	1	3	2		2	10	
24	2	2		4	4	1		1	5	
25	1	2		3	3			0	5	
26	1	1		2	2			0	10	
27				0	0			0	5	
28	2	2		4	4	1		1		
29	2	2		4	4		1	1	5	
30		1		1	1			0		
31			2	0	2		1	1	11	
32		2	1	2	3		1	1	10	
33		1		1	1			0	10	
34			2	0	2		1	1	6	
35	2	2		4	4			0	20	
36	1	1		2	2	1		1		
37				0	0			0		
38	1		1	1	2	2		2		
39	1			1	1			0		
40	2		2	2	4			0		
41						2		2		
42								0		
43							1	1		
44						1		1		
Total	34	42	21	76	97	26	15	41	131	0
Average No. of livestock/total household										
Ave/H.	0.9	1.1	0.5	1.9	2.4	0.7	0.4	1.0	3.3	0

Note: No. of sample farm household is 40.

Source: Farm household survey conducted by JICA survey team,1994

Table IV-3.10 (1/2) Daily Purchased Pig Food, Kandal Stung

Unit: Riel

Code No.	No. of pig	kg/ day	Kg / head	Riel / kg	Amount per farm
	a	b	c	d	e
46					
47					
48	1	2	2	150	300
49					
50					
51					
52					
53	2	5	2.5	150	750
54					
55					
56	1	2	2	150	300
57					
58	2	2	1	150	300
59	1	1	1	150	150
60					
61					
62					
63					
64					
65					
66					
67					
68					
69					
70	2	5	2.5	150	750
71					
72	2	2	1	150	300
73	1	2	2	150	300
74	1	2	2	150	300
75					
76	1	1.5	1.5	150	225
77	1	4	4	150	600
78	1	1	1	150	150
79					
80	1	1	1	150	150
81					
82	2	2.5	1.25	150	375
83	1	2.5	2.5	200	500
84					
85					
86					
87					
88					
89	2	2	1	250	500
90					
91	3	2	0.67	150	300
92					
93					
94					
95					
96	2	5	2.5	200	1000
97	2	5.5	2.75	150	825
98					
99					
100					
101					
102					
103					
104					
105					
106					
107					
Total A	29.0	50.0	34.2	3050.0	8075.0
Total B	25.0	42.8	25.8	2200.0	6260.0
A+B	54.0	92.8	60.0	5250.0	14335.0
Ave.		* 1.7	** 1.1	*** 97.2	434.4

Code No	No. of pig	kg/ day	Kg / head	Riel/ kg	Amount per farm
	a	b	c	d	e
108					
109					
110					
111					
112					
113	1	1.5	0.75	200	300
114					
115	5	2	0.4	150	300
116					
117	1	1	1	100	100
118					
119	1	6	6	150	900
120					
121	3	8	2.67	150	1200
122	2	7	3.5	150	1050
123	1	1	1	160	160
124					
125					
126					
127	2	3	1.5	150	450
128					
129					
130					
131					
132					
133					
134	1	3	3	150	450
135					
136					
137	2	2	1	150	300
138	3	5	1.67	150	750
139	1	1.5	1.5	150	225
140	1	0.5	0.5	150	75
141					
142					
143					
144					
145					
146					
147					
148					
149					
150					
151					
152					
153					
154					
155					
156					
157					
158					
159					
160					
161					
162					
163					
164					
165					
166					
167					
168					
169	1	1.3	1.3	240	
Total B	25.0	42.8	25.8	2200.0	6260.0

Note: * Purchased pig food per sample farm (33)
** Purchased pig food per head
*** Unit price of purchased pig food per kg.

Source: Farm household survey conducted by JICA survey team, 1994

Table IV-3.10 (2/2) Daily Purchased Pig Food, Tonle Bati

Code No.	No. of pig	Kg / day	Kg / head	Riel / kg	Amount / farm
	a	b	c	d	e
1	7	20	2.9	100	286
2					
3	3	2	0.7	100	67
4	1	1	1.0	100	100
5					
6	1	3	3.0	150	450
7	1	3	3.0	150	450
8	1	3	3.0	150	450
9	1	4	4.0	150	600
10	1	3	3.0	150	450
11	4	13	3.3	150	488
12					
13	2	3	1.5	150	225
14	1	2	2.0	100	200
15	1	2	2.0	100	200
16	2	1	0.5	120	60
17					
18					
19					
20					
21					
22					
23	2	2	1.0	150	150
24	1	3	3.0	150	450
25					
26					
27					
28	1	3	3.0	150	450
29	1	3	3.0	150	450
30					
31	1	1	1.0	100	100
32	1	5	5.0	100	500
33					
34	1	2	2.0	100	200
35					
36	1				
37					
38	2	3	1.5	150	225
39					
40					
41	2	2	1.0	150	150
42					
43					
44	1	2	2.0	150	300
Total	40	86	52	3020	7000
Average	*	3.7	** 1.3	*** 131.3	304.3

Note: * e farmer (23).
** food per head
*** g food per kg.

Source: Farm household survey conducted by JICA survey team,1994

ANNEX V

IRRIGATION AND DRAINAGE

ANNEX V

IRRIGATION AND DRAINAGE

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1. EXISTING IRRIGATION PROJECTS AROUND THE STUDY AREA

1.1 Prek Thnot Multipurpose Project

The Prek Thnot River, a tributary of the Mekong River, was studied and investigated by national and international agencies since the early 1960' as part of works carried out on the Lower Mekong Basin, as having potential to provide power, irrigation and flood control for Phnom Penh and surrounding regions. A feasibility study on the Prek Thnot Multipurpose Project was conducted in 1962. The Prek Thnot Project envisaged consists of construction of a storage dam with a hydropower station of 18 MW, construction of irrigation facilities and provision of flood control facilities. In the Prek Thnot Project, irrigation and drainage project was conceived to include 70,000 ha of land at the full development on both banks of the Prek Thnot river. The Study Area of this Master Plan is included in the Prek Thnot Multipurpose Project area.

In 1969 construction of the dam and power station started, but the works were sometimes suspended due to hostilities. In 1973 construction had to be suspended. By the 1975 on Khmer Rouge takeover, some foundation work on the dam for power generation and a diversion weir for irrigation at Roleng Chrey were completed. Irrigation canals were executed by the Cambodian Government and the upstream part of the left bank canal with related structures were constructed until the complete suspension of the works due to the war activities.

In 1991, the Re-appraisal of the Prek Thnot Multipurpose Project was carried out to provide the necessary input for feasibility analysis of the construction of a storage dam with power generating facilities and to prepare the improvement measures for the ongoing irrigation projects of the Prek Thnot Project area inclusive of preparation of a master plan for future irrigation development of the Prek Thnot area. The study was carried out by four packages, consisting of (i) power development, (ii) civil work and study coordination, (iii) power plant and equipment, and (iv) irrigation development. The reappraisal result of the irrigation development project is summarized in the succeeding section.

The major activities of the Prek Thnot Multipurpose Project are summarized in the following chronological order:

a. In 1962, a feasibility study by Japanese, Australian and Israeli consultants,

b. In 1966, decision of Mekong Committee on the implementation of the Project with fund from 12 donor countries,

c. In 1969, commencement of construction of the dam and power station,

d. In 1970, commencement of irrigation component for detailed plan of 5,000 ha under the responsibility of FAO,

e. In 1972-1973, study on technical and economic feasibility of the Prek Thnot Pioneer Project Preparation,

f. In 1973, suspension of the construction works of dam component due to hostilities, with progress of some part of dam foundation and completion of Roleng Chrey diversion weir during a period of four years from the commencement,

g. In 1975-1979, construction of a number of canals and related structures, during which Tuk Thla and Kompong Tuol regulators for the Kandal Stung and Tonle Bati areas have been constructed,

h. In 1979 preparation of detailed design of upper part of the Prek Thnot project area for an area of 12,000 ha by Vietnamese engineers,

i. In 1991, Reappraisal of the Project.

1.2 Existing Irrigation Schemes in the Prek Thnot Project

There exist the following irrigation projects along the Prek Thnot river upstream of the Study area. Those irrigation systems will use the river flow of the Prek Thnot before the river flow reaches to the Tuk Thla and Kompong Tuol Regulators. The locations are as shown in Fig. V-1.

a. Roleng Chrey Irrigation Project

b. O'krang Ambel Irrigation Project

c. Dangkor Pump Irrigation Project

The general features of the projects are described below.

(1) Roleng Chrey Irrigation Project

i) Roleng Chrey Regulator

The Roleng Chrey Regulator diverts water to the left bank and right bank main canals. It is provided with 5 steel stoplog gates which are operated by diesel engine driven motors. The right bank immediately downstream of the regulator is seriously eroded due to uneven release flow from gates. No. 2 bridge span from the left hand side is severely damaged during the Pol Pot regime and requires urgent replacement, together with repair of the No. 1 left hand bridge.

The Roleng Chrey gates are operated by Kompong Speu provincial office. The gates are intermittently opened without operation manual according to the observed water levels. In the dry season the river discharges decrease drastically, then the release of a small amount of river water is not easy. The gate operator opens the gate when the upstream water levels reach to the critical level to the embankments. The river flows at the Tuk Thla and Kompong Tuol regulators fluctuates much due to the intermittent gate operation at Roleng Chrey.

No communication on the water management practice is made between the upstream and downstream areas of the river basin. It results in much loss of water source as well as high risk of damages of facilities. It is required that water management system including the communication network has to be set on the river basin basis at the central government level.

ii)) Left Bank Main Canal System

The command area originally planned is 5,000 ha extending up to the O'krang Ambel river. The present irrigation area is estimated to be 2,000 ha in the rainy season and 1,000 ha in the dry season. A head regulator is provided to control flow to the left bank main canal. The head regulator gates of the left main canal are opened when the canal command requires water, and they are closed when the right main canal command requires water according to the request of farmers. The head regulator is equipped with 4 radial gates (4 m wide and 2.5 high each), of which 2 right hand gates are operational and 2 left hand gates are out of order. Lifting equipment are not functioning. Leakage occurs from all gates, in particular, a large amount of water leaks from a bottom floor of No. 1 gate from the left. A left hand pier is heavily damaged in Pol Pot regime and needs urgent repair.

iii) Right Bank Main Canal System

This system irrigates an area of approximately 100 ha only in the rainy season, extending close to Kompong Speu town. The canal system was constructed in the Pol Pot regime. Facilities are poor in maintenance. This canal is supplied from a bank opening of the right bank approximately 1.1 km upstream of the Roleng Chrey regulator. No head regulator is provided. At the head of the canal, a shallow pond is located with a water surface area of about 150 ha and water depth of about 2 m at the high water preserved by the Roleng Chrey gates. The water of the Prek Thnot enters to the pond when the Roleng Chrey gates are closed, and comes out on opening of gates.

(2) O'krang Ambel Irrigation Project

The O'krang Ambel Irrigation Project is located on the left bank of the Prek Thnot river. The irrigation facilities consist of a diversion weir in the O'krang Ambel river, an intake with 5 gates, a main canal, a secondary canal and tertiary canals for 2,300 ha. The project irrigation area under the original plan is 10,000 ha, out of which only 150 ha is irrigated in the rainy season at present. The canal system is poor in maintenance. Operation and maintenance of the weir and intake is carried out by Kompong Speu provincial office.

(3) Dangkor Pump Irrigation Project

Irrigation water of the project is pumped up from the left bank of by-pass channel of the Prek Thnot river at immediately upstream of Tuk Thla regulator. The project irrigation area under the original plan is 300 ha, most of which is presently not irrigated. The canal system consists of a main, secondary and tertiary canals. The irrigation facilities are poor in maintenance.

1.3 Reappraisal of Prek Thnot Multipurpose Project

The Reappraisal of the irrigation component of the Prek Thnot Multipurpose Project examined the outline of the master plan of the future irrigation development with the following alternatives:

Alternative 1 : no storage dam would be built and irrigation would be based on run-of-river water from the Prek Thnot,
Alternative 2 : a dam would be built and irrigation would have priority over power generation,
Alternative 3 : a dam would be built but generation of power would have priority over irrigation.

It concluded that the irrigation development of the respective alternatives with double cropping of rice would be as follows:

Irrigation System	Alternative 1	Alternative 2	Alternative 3
LBMC	700	2,600	2,600
RBMC	700	7,600	7,600
Dangkor	300	300	300
Kandal Stung 1_/	1,100	2,400	2,400
Roung Kou 2_/	500	2,200	2,200
Krasang, Kampoes 3_/	0	1,600	1,600
Tonle Bati	900	12,000	4,900
Others 4_/	0	5,300	5,300
Total	4,200	34,000	27,000

Note : 1_/ Area covered with the existing Kandal Stung system
2_/ Area located south of the Kandal Stung Study Area
3_/ Area located north of the Kandal Stung Study Area
4_/ Area located east of the Kandal Stung Area, outside Study Area

Implementation schedule of the master plan of development of the Prek Thnot Irrigation Component of 4,200 ha (Alternative 1) has been formulated on the basis of small scale approach in order to facilitate farmers participate in all respects of preparation, implementation, operation and maintenance of the irrigation systems. It was also based on step-by-step implementation in order to enable government institutions to increase their implementation capability. The works would be executed by employing contractors, inclusive of private sectors in design and implementation. Then the time required for completing the irrigation systems was proposed to be 8 years inclusive of preparatory works.

2. PRESENT CONDITIONS OF IRRIGATION AND DRAINAGE IN THE STUDY AREA

2.1 General Description of the Study Area

2.1.1 Irrigation and Drainage Conditions of the Kandal Stung Study Area

(1) Irrigation Condition

The Kandal Stung Study area is located in Kandal Stung District of Kandal Province, covering a gross area of 11,300 ha. The area is bounded by the Prek Thnot river on the north, the National Road No. 3 and National railway on the west, the National Road No.2 on the east and the Tonle Bati river and lake on the south.

Topography of the area in general slopes to the east, facing to Cheung Loung lake with the average of 1:1,500 to 2,000, except the northern and southern edges which are drained directly to the Prek Thnot and Tonle Bati rivers. Geomorphic land units are broadly classified into younger flood plains and older plains; the former mostly extends in the north of the Stung Toch and the later lies in the south of the Stung Toch. The older plains is a slightly elevated area with the ground elevation higher than 12.0 m.

In the Pol Pot regime 1975 to 1976, in order to maintain the required water level in the Prek Thnot river and to create a reservoir for supplying irrigation water to Kandal Stung area as well as Tonle Bati area, the Tuk Thla Regulator was constructed at its crossing point of the National Road No. 3, together with Kompong Tuol Regulator. Then, irrigation canals was constructed in the Kandal Stung area following latitudinal and longitudinal grid lines regardless of topographic conditions. Canal related structures were constructed together with canal works. The Pol Pot canal systems were provided in the north of the Stung Toch river in the younger flood plains with the ground elevation less than 12.0 m. The slightly elevated area, a south- western part of the Study area, is not provided with any irrigation system.

Since 1987 to 1991, the rehabilitation/construction of the Pol Pot canal system in the Kandal Stung area was executed by the Department of Hydrology with assistance of MCC (Mennonite Central Committee) in order to provide irrigation water and drainage to about 2,000 ha of agricultural land.

In 1991 August, the National Road No. 3 dike between Kompong Tuol and Tuk Thla regulators were washed out and the irrigation facilities of Kandal Stung Project were severely damaged by the flood. Succedingly, damages and rehabilitation of the road dike were repeatedly carried out. In 1994 August, the road dike was further breached by the flood. Therefore, irrigation for the Kandal Stung area is not conducted from the existing irrigation system for the long time.

Irrigation water supply in Kandal Stung Study areas is not reliable for long time. Under those situations, farmers hare using some different kinds of lifting irrigation. The indigenous tools for irrigating the farms appeared in the Project area, but to very limited scale.

i) Water Scoop

This method is used to lift water from the canal or a small pond near the paddy fields. This is mostly practised to supplement rainwater in the nursery period.

ii) Swing Scoop

This method is practised by two people also for the purpose to supplement water in the nursery period.

Private small capacity engine-driven pumps with rated outputs of 3 to 4 kW, having pumping capacities of 1 to 1.5 m^3/min. are commonly utilized in the area to supplement rainwater for paddy cultivation and vegetables. A total pump operation hour averages to 10 to 20 hours in ha. Rental system of pumps prevails in the area with a rental charge of 3,000 Riel per hour, equivalent to 1.2 US$ per hour.

Irrigation water sources for the Kandal Stung area are the Prek Thnot and Stung Toch. The annual river flow of the Prek Thnot is estimated to be 1,334 MCM, equivalent to 42 m^3/sec. The Stung Toch is a seasonal river, and then not reliable for irrigation. The Prek Thnot river flows in the dry season especially from January to April decrease drastically to about 2 to 4 m^3/sec. The existing irrigation intake in the upstream diverts the most of the dry season river flows at the present time.

The irrigation system existed in the Kandal Stung Study area is only the Kandal Stung Irrigation Project which has been rehabilitated during 1989 to 1991, but is not functioning well at the present time. The detailed description of the irrigation system is given in the succeeding section.

(2) Drainage Condition

Most part of the Kandal Stung Study area is drained to Cheung Loung lake through Pol Pot canals, the northern part is however directly drained to the Prek Thnot river also through Pol Pot canals. Drainage water in the south western part discharges to the Tonle Bati river and Tonle Bati lake.

According to the geomorphological conditions in the area, the younger flood plains are subject to flooding from the Prek Thnot or its tributaries, while the older plains is not susceptible to flooding. The northern part of the area, Kouk Krasang area, is sometimes flooded from the Prek Thnot due to a small capacity of the river channel. The Stung Toch river collects the spilled water from the Prek Thnot in its upstream reaches, which spreads in the Kandal Stung area. The flood water flows down along the river trails and is drained through the Pol Pot canals to Cheung Loung lake. Many fish fences, bushes, or earth bunds for irrigation intake are seen, which prevent smooth flow of the water. Diversion structures for irrigation are located in the downstream of Pol Pot canals. Due to the lack of the flow capacities of road crossing structures and back water effects of the above-mentioned diversion structures, the inundation of the low-lying area on the west side of the National road No. 2 are sometimes occurred in the rainy season.

2.1.2 Irrigation and Drainage Conditions of the Tonle Bati Study Area

(1) Irrigation Condition

The Tonle Bati Study area is located in the Bati District of Takeo Province, extending on the area of 6,900 ha in gross. The Study area is bounded by Tonle Bati lake and Tonle Bati rivers on the north, Cheung Loung lake on the east, the National Road No. 2 on the west and a district road toward Kampong Cheung village on the south.

Topography of the area is rather flat with the slightly elevated area in the central part of the area. Land units of the area belong mostly to older plains except the limited younger floodplains in the northern part.

In the Pol Pot regime 1975 to 1976, irrigation canals and their related structures were constructed in the Tonle Bati area following latitudinal and longitudinal grid lines regardless of topographic conditions. The irrigation water is taken from the Tonle Bati lake. The intake and pumping station had been constructed at the shore of the lake. During 1987 to 1990, the irrigation system inclusive of a pump station, intake, canals and related structures was rehabilitated by the Department of Hydrology with the assistance of the World Council of Church (WCC), and then the irrigation system inclusive of tertiary canals was completed for an area of about 900 ha. In 1991 August, the irrigation facilities of Tonle Bati Project were damaged by the flood. In February 1992, rehabilitation of some parts of damaged canal embankment was executed by Mekong Secretariat (executing agency) with the financial assistance of UNDP. However, irrigation facilities are presently not well functioning due mainly to insufficient rehabilitation, insufficient water level/storage of Tonle Bati lake as well as the lack of systematic O & M system.

Irrigation water supply in Tonle Bati Project areas is not reliable for long time. Under those situations, farmers are using some different kinds of lifting irrigation. Some indigenous tools for irrigating the farms, such as water scoop, swing scoop, are also used in the Study area, but to very limited scale. Private small capacity engine-driven pumps with rated outputs of 3 to 4 kW, having pumping capacities of 1 to 1.5 m^3/min. are commonly utilized in the area to supplement rainwater for paddy cultivation and vegetables. A total pump operation hour averages to 10 to 20 hours in ha. Rental system of pumps prevails in the area with a rental charge of 3,000 Riel per hour, equivalent to 1.2 US$ per hour, approximately same as that in the Kandal Stung Study area.

The Tonle Bati Study area faces to Cheung Loung lake on the east. The low-lying areas locating on the eastern edge are prone to inundation by the lake water in the rainy season. The receding paddy cultivation is practised in such low-lying area by use of stored water in small reservoirs. The excess of rainwater or drainage water discharges to the lake through Pol Pot grid canals which are widely existed in the area. The field investigation and aerial photo interpretation revealed that the existing canals and paddy field boundaries disappeared on the ground elevation of about 5.3 to 5.5 m. It is advantageous to set the boundary on elevation of 5.3 m for the Tonle Bati irrigation development where intensive infrastructure development is implemented.

There are the following five (5) small reservoirs in the Bati district. Within the reservoir areas and downstream of them, receding paddy cultivation was practised for about 600 ha. Water sources of those reservoirs are Cheung Loung lake, Tonle Bati lake or drainage water. Receding paddy cultivation areas is dependent directly or indirectly on Tonle Bati lake water.

a. Kompong Damrei reservoir
b. Pugnea Khun reservoir
c. Sam Poch reservoir
d. Svay Kham reservoir and
e. Krang Krochang reservoir

The irrigation system existed in the Tonle Bati Study area is only the Tonle Bati Irrigation Project which has been rehabilitated during 1989 to 1991, but is not functioning well at the present time. The detailed description of the irrigation system is given in the succeeding section.

(2) Drainage Condition

The drainage system of Tonle Bati area is broadly divided into three drainage systems. The eastern part of the Tonle Bati Study area is drained to Cheung Loung lake through the

Pol Pot canals running on east-west direction. The southern area is drained to the Haknuman (North-South 85) canal. While, the northern area is directly drained in the downstream of the Tonle Bati river. The drainage in the Tonle Bati Study area is presently carried out through Pol Pot canals.

The low-lying areas locating on the eastern edge of the Tonle Bati Study area are prone to inundation by the lake water in the rainy season as mentioned above. The other areas are not subject to the flooding. Run-off from the Phnom Tamao, a hilly area lying on the west of the Tonle Bati Study area, discharges to the Study area and stagnates in the western part of the Study area for some days when the heavy rain occurs, but it is used to supplement irrigation water.

2.2 Kompong Tuol Irrigation Intake

2.2.1 History of Kompong Tuol Irrigation Intake

In order to maintain the required water level in the Prek Thnot river and to create a reservoir for supplying irrigation water to Kandal Stung area as well as Tonle Bati area, the Prek Thnot by-pass channel with Tuk Thla regulator was constructed in 1975 to 1976 at Kompong Tuol village, together with National Road No. 3 dike and Kompong Tuol regulator. Besides, a flood dike along the right bank in the upstream of Kompong Tuol village was constructed to protect the existing paddy fields on the right bank from inundation by the raised water level of the Prek Thnot river. Those facilities are hereinafter referred to jointly as the Kompong Tuol Irrigation Intake.

Then, many latitudinal and longitudinal grid canals were constructed in the Kandal Stung area, together with intake and canal related structures. On those days the Prek Thnot river water was supplied to some extent to Tonle Bati lake from Kompong Tuol intake through the grid canals in Kandal Stung area

In the Stung Toch river in the immediate downstream of its crossing with the National Road No. 3, river closure dikes along the right and left banks were constructed in order to store the Stung Toch river water in the Pol Pot regime. Three outlets were constructed from the reservoir, which was connected with a grid canal system. One of the grid canal (N-S 78 canal) conveyed water to the Tonle Bati river to supply water to Tonle Bati lake. In the recent year, a connecting canal with the Prek Thnot river was constructed along the National Road No. 3 with a regulation structure near the intake of the Kandal Stung irrigation project in order to convey the Prek Thnot river flow.

In 1991 August, the National Road No. 3 dike between Kompong Tuol and Tuk Thla regulators was washed out by the flood. In the beginning of 1992, rehabilitation of road dike was executed by Mekong Secretariat (executing agency) with the financial assistance of UNDP under the "Rehabilitation of Hydraulic/irrigation Structures damaged by 1991 Floods" project. The works were implemented by Department of Hydrology. But it was washed out again by the flood in October 1992. Further the breached dike was rehabilitated in December 1993 by the assistance of NGO. Then, in March 1994, the road dike was breached again by the high flow. Urgent rehabilitation of the road dike was carried out. On August 3, 1994, the road dike was breached again at three locations by the floodwater. Under those situations, the Kompong Tuol intake has not been functioning for long time.

2.2.2 Present Conditions of Kompong Tuol Irrigation Intake

(1) Tuk Thla Regulator

This structure was constructed in a spillway channel excavated across large meanders in the Prek Thnot river at Kompong Tuol village. The regulator consists of 25 manual-operated wooden slide gates with average width of 1.1 m and gate height of 2.4 m. A bridge for National Road No. 3 is provided immediately downstream of a gate portion, having width of 18.5 m in net and length of 37.4. Downstream of the bridge portion, a gradual-inclined stilling basin is provided with bottom level of 2.5 m lower than the gate portion. A spillway channel is of length of 2.2 km and of width of about 50 m. The channel berms in the upstream and downstream sections are eroded by the flood flows. The bridge and stilling basin stand in acceptable conditions except unprotected left bank slope. The general features of the facilities are as shown in Fig.V-2.

It is reported that the gate operation under the original condition is as follows, though it does not well function at present. All gates were closed after the high water season passed, and in the beginning of the next rainy season when the high water levels occurred, one gate was first opened. As the water level rose further, successive gates were raised until the reservoir level was stabilized. The gates were raised very slowly and required considerable effort to open. Two gate operators had to work simultaneously for one gate. It took one day for one gate opening with 8 operators. To fully open all 25 gates, it required 6 to 8 days with 25 to 30 gate operators.

The flood flow on August 3, 1994 is as follows: The gates could not be fully opened. As shown in Table V-1, the discharge through the gates is estimated to be 177 m^3/sec, while the maximum flow capacity is estimated to be 260 m^3/sec if the gates are fully opened. The present capacity of releasing floodwaters of Tuk Thla regulator reduces to 68 % of the maximum capacity.

(2) Kompong Tuol Regulator

The Kompong Tuol regulator consists of 6 manual-operated slide gates with average gate width of 1.5 and gate height of 3.6 m. A bridge surface for National Road No. 3, immediately downstream of a gate portion, is located at El 14.03 m (LBKS)[1/] , having width of 8.0 m and length of 12.0. Downstream of the bridge portion, a gradual-inclined stilling basin is provided with bottom level of 1.2 m lower than the gate portion. The control of water levels was made mainly by the Tuk Thla regulator. The Kompong Tuol regulator was mostly closed and it was opened only to supplement the release of high floods. The maximum flow capacity of Kompong Tuol regulator is estimated to be 130 m^3/sec. At the present, the outflow from the gates attacks the embankment of the east route of the National road No. 3 and its slope is eroded. Seepage was observed on the right side outlet wall. The general features of the facilities are as shown in Fig.V-3.

Some gates of the two regulators are damaged and not operational. The gates are too narrow and have numerous difficulties and problems for ensuring smooth operation at the flood time. The present maximum flow capacity of both regulators is estimated to be about 400 m^3/sec. The 100 year flood discharge of the Prek Thnot river is estimated to be 1,900 m^3/sec. The present flow capacity of the gates is insufficient to flow down the high floods. Repair/replacement of gates and increase of the overall capacity of the regulator sites are urgently needed.

1/ : LBKS: referred to Local Benchmark of Kandal Stung based on which topographic maps were prepared.
Benchmark elevation at Tuk Thla : 14.314 m according to thenational geographic datum
: 13.698 m according to the LBKS

(3) National Road No. 3 Dike

On August 3, 1994, flood waters in the Prek Thnot river overtopped the road dike between the Tuk Thla and the old river channel. Two locations of the road dike were breached; south and north parts to Kompong Tuol regulator. The north part was breached due to overtopping of the flood water and the south part was breached by severe piping through the road dike. Both are the same locations damaged by the flood in 1991 August. The breaching process and case are quite similar to the previous breach. Flood waters also crossed the recently heightened road embankment between the old river course and the Stung Toch and flowed through the Kandal Stung Irrigation intake, causing damage to the main canal embankment. The National Road No. 3 bifurcates into two; western original and eastern extension routes after passing Tuk Thla regulator. The Kompong Tuol regulator is located on the western route and the breached portion is on the same route. After breaching of the road dike by the flood in August 1991, the route was diverted to the eastern route by the Ministry of Public Works, which crosses the Prek Thnot river by a Bailey bridge. The eastern route is presently used as a main route. This route was laterite paved in June 1994, having width of 10 m and shoulders of 2 m each. The Government intends to rehabilitate the western route as a main route of National Road No.3.

(4) Flood Dike along the Upstream Right Bank of Kompong Tuol

To protect the paddy fields on the right bank against the inundation of raised water by the two regulators, the flood dike of 4.0 km long from Kandal Stung intake to the railway embankment was constructed during the Pol Pot regime. The flood waters in August 3, 1994 flowed over the dike, resulting in the heavy erosion of the dike especially in the portion near the National Road. The flood water also enters the area by overtopping of the dike and through culverts and bridges under the railway.

2.2.3 Operation and Maintenance

O & M of the Kompong Tuol intake was carried out by two related Districts, Dangkor District office of Phnom Penh municipality for Tuk Thla regulator and Kandal Stung District of Kandal Province for Kompong Tuol regulator. Gate operators were appointed from two Districts, 25 for Tuk Thla regulator and 6 for Kompong Tuol regulator. To coordinate the operation of the regulator gates, a coordinating committee was organized, constituted by representatives of Hydrology Office of the two related Districts and Phnom Penh municipality. It always confronted operation conflict among the related districts. The farmers in Kandal Stung irrigation area wanted to raise water level to increase diversion water. Whereas, the farmers in both bank areas immediately upstream of the regulators tried to lower the water level to lessen inundation damage in their farm land. Sufficient institutional set-up for operation of the regulators is required to solve these issues smoothly.

2.3 Kandal Stung Irrigation Project

2.3.1 History of the Project

In the Pol Pot regime of 1975-79, ignoring previous plans and the completed canals and structures of the Prek Thnot Multi-purpose Project, an irrigation canal system was constructed in the Kandal Stung area, together with construction of Kompong Tuol Irrigation Intake. Distribution canals for irrigation was constructed, following latitudinal and longitudinal grid lines regardless of topographic conditions. Intake and canal related structures were constructed together with canal works. Major canals were located 1 km by 1 km, and distribution canals and field borders were provided in principle at 100 m interval.

Since 1987 to 1991, the rehabilitation/construction of the irrigation facilities of the Kandar Stung Irrigation Project was executed by the Department of Hydrology with assistance of MCC (Mennonite Central Committee). The primary objective of the rehabilitation of the Kandal Stung facilities is to provide irrigation water and drainage to about 2,000 ha of agricultural land. In addition during the design stage in 1986, the area of 1,100 ha located north of provincial road No. 38 was included in the project area. Then the Kandal Stung Irrigation Project was implemented to cover the area of 3,100 ha.

In 1991 August when the National Road No. 3 dike between Kompong Tuol and Tuk Thla regulators was washed out, the irrigation facilities of Kandal Stung Project were also severely damaged by the flood. In February 1992, rehabilitation of some parts of damaged canal embankment and structures of the Kandal Stung Project was executed by Mekong Secretariat (executing agency) with the financial assistance of UNDP under the "Rehabilitation of Hydraulic/irrigation Structures damaged by 1991 Floods" project. The works were implemented by Department of Hydrology.

In August 1994, the head reach of the main canal for about 400 m was washed out and the head regulator was damaged by the flood. The Kandal Stung Irrigation facilities were not functioning for a long time due to the repeated damages.

2.3.2 Irrigation and Drainage Facilities

(1) Irrigation Canal System

Rehabilitation of the Pol Pot canals and related structures was executed in a period from 1987 to 1991 by the Department of Hydrology, with the joint effort of the Kandal Stung District, Kandal Province and with assistance of MCC. The Department of Hydrology provided earth moving equipment, operators, supervisor for construction, local materials, transport and salaries for labourers, and the District supplied skilled workers, and labourers for earth moving. MCC contributed construction materials and equipment and fielded a civil engineer. The layout of the existing irrigation canal system is as shown in Fig. V-4.

The Kandal Stung Irrigation Project was planned to irrigate 3,100 ha. Irrigation water to the Kandal Stung area was diverted from the right bank opening in front of Kompong Tuol regulator. A shallow and wide borrow area, adjacent to National Road No. 3, conveyed water to the intake of the Kandal Stung Irrigation Project. No irrigation water is diverted at present to Kandal Stung area due to repeated damages of the road dike. The irrigation canal system consists of main, laterals and tertiary canals with related structures. The rehabilitation of distribution canal system was basically based on the Pol Pot layout, although some new canals and structures were added in the rehabilitation works.

The following are the general features of the existing canals and structures and the lists of the existing canals and related structures are as shown in Table V-2 and V-3.

Description	Length			Number
	Total	New	Rehabilitation	
	(km)	(km)	(km)	(nos)
Irrigation Canal				
Main Canal	5.30	0	5.30	1
Lateral Canal	13.23	6.38	6.85	5
Tertiary canal	38.03	18.09	19.94	35
Related Structure				
Structures related to main and lateral canal	-	-	-	28
Turnout for tertiary canals	-	-	-	38

The present conditions of canals and structures constructed so far are described hereunder.

i) Irrigation Canals

a. Main Canal

The capacity of the main irrigation canal at its head is 9.73 m^3/sec for an area of 3,100 ha inclusive of the future extension area. The canal is the Pol Pot canal (EW63), which is a large and deep canal.

The canal runs on the ground surface slope of approximately 1:2,000. The canal crosses the high-elevated area with excavated sections in the upstream, and it runs in low-lying area with embankment sections in the downstream reach. Canal base levels are not appropriate, in some place too deep, in other places shallow. Heavy erosion occurs on canal inside and outside slopes in some places. Embankment appears erosible and dispersive soils embankments. To prevent erosion on canal slopes, slope protection by means of the lining and sod facing will be needed as well as reshaping of canal embankment

The water level of the main canal was set to be 12.00 m (LBKS) which was marked on the wall of the head regulator of the main canal. However, the main canal water levels never reached to the originally designed ones, El 12.00 m except high floods. According to the operation sequence of the Tuk Thla regulator, when the water surface of the main canal reached to this level, all gates of the Tuk Thla regulator are opened. In those cases, the water surface at the Tuk Thla regulator is considered to be about 1 m above the crest of the gate according to the bench mark and structure dimension survey. It is understood the main canal received waters with surface level at about 11.0 m. Then the upstream area lying in 11.0 to 12.0 m in elevation always is suffered from the lack of water.

b. Lateral

Five Laterals branch from the main canal. Pol Pot canals are used for some of Laterals (Lateral-1, Lateral-2, Lateral-3, and Lateral-5) which are level-crossed with other Pol Pot canals. The canal sections in such reaches are wide and deep against their small command areas. Irrigation water diverted from the main canal goes out to the drainage canals or drain water enters to the laterals at level-crossed locations. Water losses are much and it is difficult to convey waters sufficiently to the tail end. A distinctly separate system of irrigation and drainage canals enables to improve irrigation water management as well as to attain reliable water supply to the tail end

Heavy erosion occurs on canal inside and outside slopes in some places. Embankment is likely to be constructed by use of erosible and dispersive soils. Most lateral canals require the reshaping of canal cross sections and improvement of embankment.

c. Tertiary Canals

No tertiary canal receives water from the main canal and lateral canals, some canals are served with water from drains. Before damage of the regulators, the amount of the water was scarce and water levels in the canals were low so that the gravity irrigation was difficult. Most of tertiary canals are levelled by farmers or filled with eroded soils due to no water supply for long time. Almost all of tertiary canals require the reshaping of canal section and improvement of embankment.

Tertiary canals in the upstream area are provided at about 1 km interval having lengths of about 1 to 2 km. Then, their command areas are too large. Whereas, the tertiary blocks in the downstream are small, that induce a large number of turnouts on the Lateral canals. The present tertiary system makes it difficult to attain efficient water management of distribution system and on-farm system, as well as sustainable O&M of on-farm facilities by water users.

ii) Structures

The present conditions of the structures are as shown below.

a. Lack of gates on many turnouts and check structures,
b. Erosion of canal sections downstream of some check structures in main and lateral canals,
c. No provision of platform cover on the structures
d. Turnout barrels are filled up with sediment

Most of the existing structures need repair or desiltation.

(2) Drainage System

Drain water in the Project area discharges to Cheung Loung lake through Pol Pot canals. There are many obstacles in such drainage canals to prevent smooth flow of water. With construction of the irrigation canals smooth drain flow is disturbed. Therefore inundation or flooding are often occurred in low-lying areas.

Many fish fences, bushes or earth bunds for irrigation intake are seen, and due to the lack of the road crossing culverts, the inundation on the paddy fields was always occurred on the west side of the Road No. 2. Pol Pot canals used as drainage canals in the Project area supply irrigation water to the downstream areas and Pol Pot diversion structures are located downstream, resulting in ill-drainage condition in the Project area. The main drainage canal be needed to connect the major drainage canals in turn to field drainage canals with the above-mentioned lake.

2.3.3 Irrigation and Drainage Conditions

The rehabilitation of irrigation system was completed in 1991. However, since breach of the road dike at the Kompong Tuol regulator in 1991 August, occurred succedingly in 1992 and 1994, the irrigation canals have been completely empty, because the water is not set up and the water level in the Prek Thnot river is too low of the water to enter the main canal. Therefore irrigation from the canals system can not be carried out even in the rainy season. Farmers excavated canal embankments for taking rain water gathered in the canals, and draining their farm land. Those conditions accelerate the deterioration of the canal facilities.

To cope with those difficulties, farmers in the Kandal Stung project area are using small scale pumps for supplementing rainwater for paddy cultivation, and the number of pumps tends to increase. The farmers are keen on the rehabilitation/improvement of irrigation canal system.

The ground surface generally slopes toward the east with the average gradient of 1/1,500 to 1/2,000. Although the ground surface gradient is sufficient for natural drainage, the drainage water stagnates sometimes in the rainy season in the low-elevated area adjacent to the National Road No. 2. It is attributed to the low flow capacities of Pol Pot canals in their

downstream sections. Most of the Pol Pot canals are used as dual purpose canals which have diversion structures in the canals. Those irrigation structures raise the water levels, which reduces canal flow capacities.

The river trail menders in the southwestern part of the Kandal Stung Project area. When the flood water of the Prek Thnot river spills out from the Kompong Tuol Intake, some part of spilled water flows along the river trail. The flow of the water is disturbed by irrigation canals, roads, or earth bunds. In the downstream part the water spread over the paddy fields, resulting in damages to public facilities and farm produces.

2.3.4 Operation and Maintenance

The Kandal Stung District Office is responsible for O & M of a main and lateral canal system. In fact, however, the communes were operating the gates of canals in their areas. Maintenance and repair of the canals and structures was not carried out due to the lack of systematic O & M organization, O & M manual and O & M fund. Farmers organizations are not existed yet, then O & M of on-farm systems and water management were not executed.

2.4 Tonle Bati Irrigation Project

2.4.1 History of the Project

In 1975 to 1979, the canal system of the Tonle Bati area was constructed, basing on water source from the Tonle Bati Lake water. The canals of NS and EW directions were constructed regardless of topographic conditions of the irrigation area. The intake and pumping station were constructed at the head of NS 84 canal. A spillway of the Tonle Bati lake was provided with stoplogs at the outlet on the eastern part of the lake, for which improvement was made in 1992 with provision of 4 slide gates in front of the previous outlet of stoplogs.

In 1985, the World Council of Church (WCC), Geneva, prepared the plan of integrated agricultural development project of the Tonle Bati Area. It consisted of the rehabilitation of irrigation canal system for an area of about 6,000 ha inclusive of a pump station, setting-up of agricultural and demonstration center and provision of some agricultural extension services. During the period of 1987 to 1990, the rehabilitation of irrigation system was executed with the assistance of WCC for about 900 ha.

In 1991 August, the irrigation facilities of Tonle Bati Project were damaged by the flood. In February 1992, rehabilitation of some parts of damaged canal embankment was executed by Mekong Secretariat (executing agency) with the financial assistance of UNDP under the "Rehabilitation of Hydraulic/irrigation Structures damaged by 1991 Floods" project.

However, it is presently not well functioning due mainly to insufficient water level/storage of Tonle Bati lake as well as the lack of systematic O&M system.

2.4.2 Irrigation and Drainage Facilities

(1) Irrigation Canal System

Rehabilitation of the irrigation canal and related structures were executed in a period of 1987 to 1991 by the Department of Hydrology, Bati District, Takeo Province with the assistance of WCC. The Department of Hydrology provided earth moving equipment, operators, supervisors for construction, local materials, transport and salaries for labourers, and the District supplied skilled workers, and labourers for earth moving. WCC supplied

construction materials and equipment, and fielded a civil engineer. The layout of the existing canal system is as shown in Fig. V-5.

The Tonle Bati Irrigation Project was planned to irrigate 6,000 ha. Irrigation water to the Tonle Bati area is diverted from Tonle Bati lake through intake and pumping station. The irrigation canal system consists of main, laterals and tertiary canals with related structures. The distribution canal system is basically based on the Pol Pot layout, and then many efforts to introduce the lake water were made with new canals and structures by the Department of Hydrology.

The following are the general features of the canals and structures rehabilitated /constructed so far and the list of the canals and related structures are as shown in Table V-4, and V-5:

Description	Length			Number
	Total	New	Rehabili-tation	
	(km)	(km)	(km)	(nos)
Irrigation Canal				
Main Canal 1_/	9.70	4.05	5.65	3
Lateral Canal	9.11	5.64	3.47	7
Tertiary canal	20.00	18.55	1.45	21
Related Structure				
Structures related to main and lateral canal	-	-	-	19
Turnout for tertiary canals	-	-	-	22

Note : including Haknuman canal

i) Tonle Bati Lake

Tonle Bati Lake is a water source of the existing Tonle Bati irrigation project. The lake is a natural reservoir with the total storage capacity of 16.7 million m^3 and water surface area of 750 ha at the lake water level of 7.80 m (LBTB)2_/ . The water levels of the lake in the past is as shown in Fig.V-6. The catchment area is very small, then the lake water lowers quickly after finishing the rainy season. An intake and spillway are located at the southeast and east end, respectively. The lake is surrounded with embankments on the north and east, with the crest levels ranging from 8 m to 10 m. The Pol Pot canals discharge to the lake from the north, having regulating gates at the crossing with the embankment.

There is Pagoda and recreation center adjacent to the southern coast. The intake water level for Tonle Bati area will be required to be 7.80 m. The Pagoda northern yard is sloping toward the lake with the ground elevations of 7 to 8 m. The embankment will be extended to protect Pagoda from intrusion of the lake water. The Tonle Bati recreation center is located west of Pagoda. The water level in the dry season has to be preserved for guests of the center. The water level of 5.5 m will be required, of which water front will be 100 to 150 m inward from the rainy season water front.

ii) Pumping Station and Spillway

a. Pump Station and Intake

2_/ : LBTB : referred to Local Benchmark of Tonle Bati based on which topomaps of Tonle Bati area were prepared. Benchmark elevation at Tonle Bati Development Center
: 8.065 m according to LBTB
: 7.917 m according to LBKS

The pumping station is provided with three sets of diesel engine driven pumping equipment having capacities of 8 m^3/min (one set) and 5 m^3/min (each two sets). Pumping capacity is not sufficient to supply irrigation water to the whole Project area. It is used only to supply supplemental water during the cropping season. An intake structure is of concrete box barrels with 1.5 m wide and 3.75 m high. The culvert bottom is located at the elevation of 4.7 m. The regulation gates are not provided.

b. Spillway

At the outlet of the lake, the spillway with a bridge for National Road No. 2 is located. In August 1991, the floodwater spilled over the lower part of the National Road No. 2. In 1992, 4 slide gates were provided by the Department of Hydrology in front of the stoplogs gates of the Pol Pot structure, but the bridge remains still heavily damaged.

There is an operation conflict of the spillway gates between farmers. Farmers in Kandal Province having paddy fields along the lake shore want to spill out the lake water to drain off their paddy fields. Release of the lake water occurs the short of water for the Tonle Bati area in Takeo Province. In order to store and utilize the water released from the spillway, Kompong Damrei reservoir was constructed by the Takeo Province far downstream of the spillway. Supply of the lake water will be needed to that reservoir.

iii) Irrigation Canals

a. Main Canal

The capacity of the main irrigation canal (M1) at its head is 9.78 m^3/sec which covers about 4,000 ha of land including the future extension area. M1 canal was newly excavated to run the central part of the Project area, branching from Pol Pot canal (Haknuman canal). The central part of the project area is higher elevated, having the ground elevations of 7 to 7.5 m To serve such a area, the large canal size was adopted with the mild slope. The excavated canal berm encounters erosive heavy clay layers in older plains. Then canal banks and slopes are heavily eroded and the inspection road could not be passed by the car. To prevent erosion on canal slopes, slope protection by means of the lining and sod facing will be needed as well as reshaping of canal embankment.

The water level at the head of the main canal was set to be 7.80 m. However, the lake water levels go down below the required water level mostly throughout the year except a half or one month in high floods. With augmented water from the Prek Thnot, the water level and volume of the lake have to be maintained to ensure reliable irrigation to the Tonle Bati area.

Even though the lake water is augmented from the Prek Thnot, the water levels go down in the dry season. It is needed to introduce supplemental lifting irrigation.

b. Lateral

Seven lateral canals were constructed in the Study area, out of which three laterals was constructed by means of rehabilitation of Pol Pot canals. Heavy erosion occurred on canal and embankment slopes in Lateral-4 and Lateral-55. Most lateral canals require the reshaping of canal cross sections and improvement of embankment.

c. Tertiary Canals

Most of tertiary canals are filled with eroded soils due to no water supply for long time. Almost all of tertiary canals require the reshaping of canal section and improvement of embankment.

iv) Canal Structures

The present conditions of the structures are as shown below.

a. Lack of gates on many turnouts and check structures,

b. Erosion of canal sections downstream of some check structures in main and lateral canals,

c. No provision of platform cover on the structures

d. Turnout barrels are filled up with sediment

Most of the existing structures need repair or desiltation.

v) Connection Canal NS78

A connection canal has been constructed on the north-south No.78 during the Pol Pot time to convey water from the Prek Thnot via the Stung Toch river to the Tonle Bati river. The canal was re-constructed by the Department of Hydrology but it does not function due to rather high bottom level and no diversion structure in the Stung Toch river. Since the canal runs relatively high-elevated area, the canal is so deep and the canal berm encounters dispersive clay layers. Further, canal slopes and spoil banks are heavily eroded, and eroded soils deposit on the canal bottom. Removal of soils and slope protection will be needed.

(2) Drainage System

The drainage system of the Tonle Bati area is broadly divided into three drainage systems. The eastern part of the Tonle Bati area is drained to Cheung Loung lake through the old Pol Pot canals which run on east-west direction. The southern area is drained to Haknuman canal, one of the large Pol Pot canals in the area. The northern area is directly drained to the downstream reaches of the Tonle Bati river.

The drainage canals constructed in the Tonle Bati area are the tertiary drains and consist of the rehabilitated canals of Pol Pot canals and newly constructed drainage canals. Those drainage canals are connected with Pol Pot canals. Some of the drainage canals are filled up with sediment and are not functioning at the present. The list of the drainage canals constructed so far is as shown in Table V-6 and summarized below.

Tertiary Drainage Canal	Length (km)	Number
Improvement canal	1.08	1
Newly constructed drainage canal	10.58	10
Total	11.65	11

2.4.3 Irrigation and Drainage Conditions

The water source of the Tonle Bati area depends on the stored water in Tonle Bati lake which has the gross storage capacity of 16.8 million m^3 at the maximum water level of 7.8 m. The lake water level has to be maintained less than El. 7.80 m to avoid submergence of the Pagoda located in the lake side. On the other hand, the Tonle Bati Project area is of fairly flat

topography having the highest elevation of about El. 7.5 to 7.8 m. Water levels in the lake draw drown considerably after rainy season.

The Main Canal No. 3 commands a relatively low-lying area compared with the lake water levels. Then, the lake water is introduced to such area in the rainy season. Whereas, Main Canal No. 1 commands the high elevated and flat area to which gravity irrigation is difficult from the lake. Pump irrigation is inevitably required.

The fuel for pumps was supplied from WCC and Kandal Province with 9,000 lit. in 1993. Pump operation in 1993 was made in May and September for the purpose to supply irrigation and domestic water. Farmers have to use small private pumps to lift water from canals to their fields even in rainy season cropping. The dry season irrigation area is estimated to be 20 ha, and the rainy season supplemental irrigation is estimated to be 100 ha

Although drainage canals are not sufficiently provided, drainage problems are not evident except low-lying areas in the lake shore of Cheung Loung lake. The low-lying areas locating on the eastern edge are prone to inundation by the lake water in the rainy season. The receding paddy cultivation is practised in such low-lying area by use of stored water in small reservoirs. Non-availability of lake water levels does not permit the provability analysis of lake water levels. According to the field investigation and aerial photo interpretation, the existing canals and paddy field boundaries disappear on the ground elevation of about 5.3 to 5.5 m. It is advantageous to set the boundary on elevation of 5.3 m for the Tonle Bati irrigation development project where intensive infrastructure development is proposed.

2.4.4 Operation and Maintenance

The Bati District is responsible for pumping operation and spillway gate, and the communes are operating the gates of canals in their area. In fact, however, maintenance and repair of the canals and structures is not carried out due to the lack of systematic O & M organization and O & M fund. Responsibility of the operation of the spillway gates belongs to the Bati district. But, the gate operation is made customarily according to the request of farmers in the downstream of the Tonle Bati river for supplying irrigation water to their fields, regardless of the overall water management to the Tonle Bati area.

Farmers organizations are not existed yet, then O & M of on-farm systems and water management are not executed.

3. DEVELOPMENT PROSPECTS AND CONSTRAINTS

The development prospects and the main development constraints of the irrigation and drainage in the Study area are pointed out as follows:

(1) Prospect

a. Presence of farming population with a knowledge of irrigated rice cultivation under difficult circumstances,

b. Presence of pump-up irrigation farmers to supplement rainwater,

c. Water availability in the Prek Thnot river and Tonle Bati lake.

(2) Constraints

i) Unreliable Water Supply from the Project Canals

Most areas can not receive irrigation water supply from the project canals due to damage of Tuk Thla and Kompong Tuol regulators in Kandal Stung area and scarce water of Tonle Bati lake in Tonle Bati area. Small scale pump irrigation tends to increase in the project areas.

ii) Lack of Flow Capacity of Tuk Thla and Kompong Tuol Regulators

Breach of the National Road No. 3 dike repeatedly occur due to lack of flow capacity of both regulators and insufficient construction of the road dike.

iii) Lack of Funds for Rehabilitation/Reconstruction and Operation and Maintenance

No maintenance and repair of canal systems due to O&M costs accelerates the damage of the canal facilities.

iv) Inefficient Irrigation Canal System with Inclusion of Pol Pot Canals

Some of lateral and tertiary canals level-cross with Pol Pot canals, that results in large losses of irrigation water and difficult water management.

v) Lack of Systematic Operation of Irrigation System Including O & M Organization

Due to the lack of water management system on the Prek Thnot river basin basis, river flows fluctuates much at the Kompong Tuol, that makes effective use of river flows difficult.

4. IRRIGATION AND DRAINAGE DEVELOPMENT PLAN IN THE STUDY AREA

4.1 Basic Concept of Overall Irrigation and Drainage Development Plan

The Reappraisal of the Prek Thnot Multipurpose Project examined the irrigation potential for three development alternatives, i.e. (i) without Prek Thnot reservoir case, (ii) with Prek Thnot reservoir case having irrigation priority for reservoir operation, and (iii) with Prek Thnot reservoir case having power generation priority for reservoir operation. The Study results showed that irrigation development without dam was limited only to 1,600 ha for Kandal Stung and 900 ha for Tonle Bati. Without creation of the Prek Thnot multipurpose dam, irrigation area of the dry season is very limited. However, under with reservoir condition, large irrigation potential was revealed. Since the Study area is included in the Prek Thnot Multi-purpose project area, the development plan of the Study area is studied through the following alternatives:

a. Irrigation development plan without Prek Thnot reservoir

b. Irrigation development plan with Prek Thnot reservoir

In formulating the development plan, the following basic considerations are taken into account:

i) Improvement/rehabilitation of existing irrigation and drainage facilities to the area which can be irrigated by run-of-river water of the Prek Thnot river

Despite the efforts carried out to the development in the Kandal Stung and Tonle Bati areas, the irrigation effects is not satisfactorily realized. With a view to quick response to irrigation development and economic implementation, rehabilitation/improvement of the existing irrigation and drainage facilities is given priority.

ii) Development priority to the area with soil suitability for irrigation development

The land evaluation classified the Study area into five classes of land suitability for irrigation development. The land belonging to three classes, i.e., "highly suitable", "moderately suitable" and "marginally suitable" are selected for the overall irrigation development area. The areas, thus selected, amount to 4,200 ha in Kandal Stung area and 4,200 ha in Tonle Bati area.

iii) An equal distribution of available water to the schemes envisaged in the Prek Thnot multipurpose project area

The Kandal Stung and Tonle Bati areas belong to the Prek Thnot multipurpose project area. Without dam plan is based on that the run-of-river water of the Prek Thnot is evenly shared to the envisaged Prek Thnot irrigation schemes.

iv) Stabilisation of paddy cropping in the rainy season, and diversification of cropping in the dry season

Reliable irrigation will be ensured for the proposed cropping patterns aiming at stabilisation of paddy cropping in the rainy season, and diversification of cropping in the dry season with introduction of upland crops.

4.2 Irrigation and Drainage Water Requirements

4.2.1 Irrigation Water Requirements

(1) General

The crops proposed for the Project are paddy for rainy season, and paddy, maize and vegetables for dry season. The irrigation water requirements for them are separately estimated according to the proposed cropping patterns for respective irrigation systems.

The irrigation water requirement for the Project are estimated, using the climatic data for consumptive use of water and effective rainfall on the basis of the modified Penman method.

The irrigation water requirements are estimated by the following procedures:

i) Paddy Rice

a. Estimate of paddy water consumption by product of reference evapotranspiration by crop coefficient relating to the crop growth stages, CU

b. Estimate of percolation rate, P

c. Estimate of effective rainfall, ER

d. Estimate of nursery water, NU and puddling water requirement, PU

e. Estimate of net water requirement, NR

$$NR = CU + P - ER + NU + PU$$

f. Estimate of gross water requirement, GR, by dividing the net water requirement by irrigation efficiency

ii) Upland Crops

a. Estimate of crop water consumption, CU

b. Estimate of pre-irrigation requirement, PI

c. Estimate of effective rainfall, ER

d. Estimate of net water requirement, NR

$$NR = CU + PI - ER$$

e. Estimate of gross water requirement, GR, divided net water requirement by irrigation efficiency

(2) Consumptive Use of Water

i) Consumptive Use by Crops

Consumptive use of water by crops is estimated as a product of reference evapotranspiration by crop coefficients relating to crop growth stages. The climatic data at Phnom Penh station is used for calculation of reference evapotranspiration by the modified Penman method.

The reference evapotranspiration thus calculated is as summarised below.

Unit: mm/month

Jan.	Feb.	Mar.	Apr.	May.	Jun	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
145	161	206	188	165	149	150	147	132	136	135	142

The crop coefficients of respective crops are estimated with reference to "Irrigation and Drainage Paper, Crop Water Requirements" FAO. In calculating the water requirement, crop coefficients are estimated on a half-monthly bases according to the proposed cropping schedule.

ii) Percolation

The percolation rate measurements in the Project area were conducted by means of cylindrical instruments (diameter of 30 cm) in the field investigation periods of 1993 and 1994 at four representative areas. Based on the result of the investigation, the percolation rate of 1 mm/day is adopted in estimating irrigation water requirements for paddy cropping.

iii) Puddling Water and Pre-Irrigation Requirements

Puddling water requirements consist of water equivalent to the difference in the soil moisture before and after puddling, standing water required above the soil surface, evaporation and percolation losses from paddy fields. The puddling water requirement is assessed to be 150 mm. Upland crops are scheduled to follow in paddy fields within a short time after paddy harvesting. In such cases, pre-irrigation for upland crops cultivation is not needed because of available residual moisture.

iv) Nursery Water Requirement

Nursery water requirements consist of water needed for preparation of nursery beds, and evapotranspiration and percolation during a nursery period. Water demands for nursery beds are estimated for the areas of 5 % of paddy cropping areas.

(3) Effective Rainfall

The effective rainfall for paddy fields and upland fields are separately estimated based on the rainfall data. Rainfall data of Phnom Penh Station is used in the calculation.

i) Paddy Field

By use of the daily rainfall data at Phnom Penh Station, effective rainfall was estimated by means of the daily water balance between rainfall and requirement. Based on the above result, correlation between half-monthly rainfall and its effective rainfall was estimated for the purpose of calculation of the long term water assessment as shown in ANNEX I. The relation can be expressed as follows:

In case of R less than 140 mm (half-month):

$$ER = 0.67 * R - 3.4 \quad (mm/half\text{-}month)$$

In case of R larger than 140 mm (half-month):

$$ER = 0.21 * R + 60.6 \quad (mm/half\text{-}month)$$

ii) Upland Field

Based on the evapotranspiration/precipitation ratio method prepared by USDA, the relationship between average monthly effective rainfall and mean monthly rainfall is drawn for the different values of the average monthly crop water requirement.

(4) Irrigation Efficiency

Irrigation efficiencies of paddy field irrigation and upland field irrigation are determined, taking into account the following conditions:

a. Most of soils in the Project area are medium to fine soils and the surface irrigation methods will be a border or furrow method. Then, field application efficiency of 70 % is applied for upland crop irrigation.

b. Application efficiency of paddy cropping is set to be 85 % in consideration of limited irrigation service areas.

c. Conveyance efficiency is estimated to be 76 % on the basis of the 85 % and 90 % for main/lateral canal and on-farm canal, respectively.

Overall irrigation efficiency for paddy and upland cropping are summarised as follows:

Irrigation Efficiency	Paddy Cropping	Upland Crop
Application efficiency	85%	70%
Conveyance efficiency	76%	76%
On-farm canal	(90%)	(90%)
Main and Lateral	(85%)	(85%)
Overall efficiency	65%	53%

(5) Diversion Water Requirement

Crop water requirements for the respective representative areas are estimated on the basis of the above mentioned calculation conditions. Water requirements and diversion water requirements of for Kandal Stung and Tonle Bati areas are calculated as shown in the Table V-7, V-8 and V-9. The following are the summary of the diversion water requirement of the proposed cropping patterns of Kandal Stung Irrigation Project 1,950 ha and Tonle Bati Irrigation Project 1,600 ha.

i) Average Diversion Water Requirement

Unit: MCM

	Jan.	Feb.	Mar.	Apr.	May.	Jun	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Tatal
Kandal Stung	2.27	1.75	0	0.11	2.04	2.98	4.98	2.93	1.26	2.20	2.30	3.29	26.11
Tonle Bati	2.01	1.55	0	0.08	1.67	2.45	4.09	2.41	1.07	1.93	2.02	2.93	22.21

ii) Maximum Diversion Water Requirement (see Table V-8)

a. Unit design water requirement with 80 % dependability for main system 1.40 lit./sec/ha

b. Unit design water requirement for tertiary system 1.72 lit./sec/ha

4.2.2 Drainage Water Requirements

Drainage water requirement for paddy fields was estimated on the assumption that 5-year, three day continuous rain storm would be drained from paddy fields within three days.

(1) Design Storm

Three-day rainfall of 1 in 5 years probability is 153 mm according to the hydrological analysis of rainfall at Phnom Penh station.

(2) Run-off Coefficient

Run-off coefficient of 0.75 is applied taking land use and topography into account.

(3) Drainage Water Requirement of Paddy Fields Area

Drainage water requirement of paddy field areas is estimated to be 4.4 lit./sec/ha by the following formula:

$$Q = q \times A$$

$$q = (C \times I \times 10^4) / (3 \times 24 \times 3600)$$

where, Q : Drainage discharge (lit./sec)
q : Drainage water requirement (lit./sec/ha)
I : Design rainfall, 5-year, three-day maximum rainfall (mm)
C : Peak run-off coefficient of paddy field, 0.75
A : Drainage area (ha)

4.3 Improvement Plan of Kompong Tuol Irrigation Intake

4.3.1 Design Discharge and Water Levels

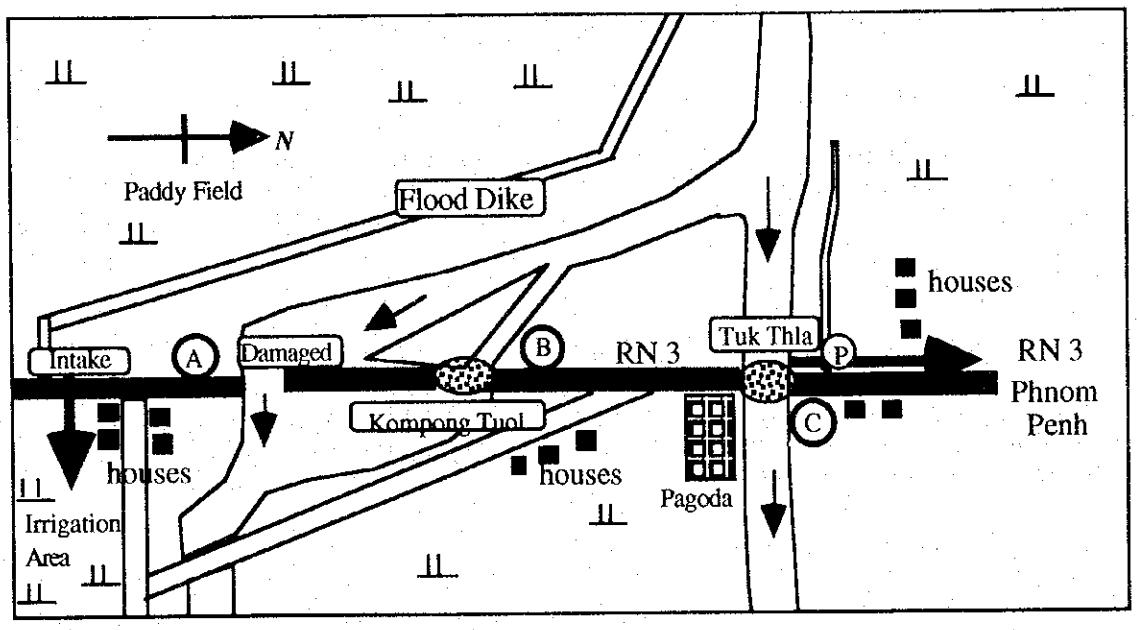
The design flood discharge and water levels for rehabilitation of Kompong Tuol intake is set as follows:

a. Flood Discharge at 100-year return period without Prek Thnot dam : 1,900 m^3/sec
b. Normal operation water level : EL. 11.50 m
c. Allowable maximum flood water level : EL. 13.00 m

4.3.2 Selection of Recommended Rehabilitation Plan

The schematic layout of the existing Kompong Tuol Irrigation Intake is as illustrated below.

Existing Schematic Layout around Kompong Tuol & Tuk Thla Regulator



In order to formulate a suitable rehabilitation plan for Kompong Tuol intake, the following five alternative cases were studied, of which the general plan is as shown in Table V–10 and illustrated in Fig.V-7.

Case-1 Improvement of the existing two regulators and construction of an overflow type spillway.

Case-2 Improvement of the existing Tuk Thla regulator, demolishing of the existing Kompong Tuol regulator and construction of an overflow type spillway.

Case-3 Improvement of the existing Tuk Thla regulator, replacement of the existing Kompong Tuol regulator with a new regulator and construction of an overflow type spillway.

Case-4 Improvement of the existing Tuk Thla regulator and replacement of the existing Kompong Tuol regulator with a new regulator consisting of a rubber-made dam and bridge.

Case-5 Construction of a new regulator at Kompong Tram site which is located about 25 km upstream of the existing Kompong Tuol Irrigation Intake.

The Case-1 and Case-2 confront the limited site for providing the long overflow spillway. The preliminary cost comparison was made for Case-3, Case-4 and Case-5. The construction of Case-4 was more costly than the Case-3, due mainly to the expensive cost of concrete bridge inherently required for rubber type weir. Case-5 was also not economically advantageous, attributed to the high civil work cost for a weir, bridge and a connection canal for 25 km up to the Kompong Tuol. The Case-3 was selected for the recommended plan.

4.3.3 General Features of Improvement Plan

The general features of the rehabilitation of Kompong Tuol intake are as shown below.

(1) Tuk Thla Regulator

The gate portion will be replaced with a new structure. The existing bridge for the National Road No. 3 and stilling basin are used, with additional provision of downstream protection. Five (5) motor driven roller gates, 6 m width and 3 m height, will be provided.

(2) Kompong Tuol Regulator

The outflow from the existing Kompong Tuol regulator is attacking the downstream road embankment, causing bank erosion. Seepage was observed on the outlet wall. The existing Kompong Tuol regulator will require much cost in the future to maintain the structure in a good operational condition. The existing regulator will be demolished and replaced with a new regulator.

(3) Overflow Type Spillway

Required design capacity of the proposed spillway is 850 m^3/sec. The proposed section has a trapezoidal embankment section covered with concrete coverings and the required length is 400 m in gross. The proposed spillway will be provided at the north side of new Kompong Tuol regulator. The proposed crest is at EL. 11.50 and will be used for National Road No. 3 under normal flow conditions of the Prek Thnot river.

(4) Road Embankment

Foundation treatment, selection of embankment materials and compaction of the existing embankment are not sufficient. High embankment between the Kompong Tuol regulator to the old river channel is liable for failure when the high reservoir levels are maintained. A new embankment is located slightly upstream from the existing route with the straight line.

(5) Flood Dike along Upstream Right Bank and Left Bank

The present flood dike located on the right bank of the Prek Thnot river is improved through re-shaping of embankment with laterite covering for 4.0 km in length. The left bank embankment will e extended to reach to the village road for 1.0 km in length. The proposed top width of both embankments is 4.0 m.

(6) Radio Communication System

The present water management of the irrigation system including regulators on the Prek Thnot river was made by the respective provincial or district office. To make effective water management of the Prek Thnot river flow in the dry season as well as the flood season, the radio communication system will be installed: The station network is as follows;

a.	Main station	- Department of Agricultural Hydraulics and Hydrometeorology, Phnom Penh
b.	Branch station	- Water management Office of DAHHM
c.	Site station	- Kompong Speu provincial office of Hydrology (for Roleng Chrey regulator)
		- Kompong Tuol regulator office to be prepared

a)	Tuk Thla Regulator	Replacement of gates, (width 6 m x height 3 m x 5 sets)
b)	Kompong Tuol Regulator	Replacement of existing regulator, (gate: width 6m x height 5m x 5 sets, bridge: width 15 m)
c)	Spillway	Overflow type, 400 m in length
d)	Road Dike	Total width 15 m, asphalt pavement & width 9 m
e)	Flood Dike on Upstream Right Banks	Length of 4 km and 1 km for right and left banks dike crest width 4 m
f)	Radio Communication System	Main, branch and two site stations

4.4 Irrigation and Drainage Plan of Kandal Stung Area

4.4.1 Delineation of Irrigation Area

Irrigation development area of the Kandal Stung area is delineated from the following basic considerations:

(1) Area to be Commanded from Existing Irrigation Canal System

Main, laterals and some of tertiary canals have been constructed for an area of about 2,000 ha, although they are presently not well functioning. Effective utilisation of the existing facilities is first taken into account through rehabilitation and reactivation. The canal system of overall irrigation development plan of Kandal Stung area will be based on the existing canal layout.

Rehabilitation of the existing Tuk Thla and Kompong Tuol regulators are indispensable for the Kandal Stung area as well as Tonle Bati area. After improvement of the regulators and road dike, diversion of irrigation water is ensured for both areas. The original design water level at the intake of the existing Kandal Stung Irrigation Project has been set to be El. 12.00. In order to avoid the risk of inundation in surrounding areas due to the raised water, a design high water level at Kompong Tuol regulator is revised to be El. 11.5 m.

(2) Extent of Suitable Soils for Irrigation Development

According to the land use plan, the irrigable area will be delineated to cover the areas classified as Class-1 to Class-3. With reference to the soil classification map, the area lying north of the Stung Toch river are well incorporated in the irrigation development area in terms of soil and topographical conditions. Whereas the area locating south of the Stung Toch river are excluded from irrigation development. The upstream area of the main canal, which is not served from the canal at the present but is irrigated by private pumps, is included.

On the basis of the above-mentioned condition, the area of 4,200 ha is suitable for irrigation development for Kandal Stung area. The extent of the area is as summarised below and the location is as shown in Fig. V-8.

Location	Irrigation area (ha)
1. Existing Irrigation area	1,950
2. Southern and northern areas (Kouk Pring, Kouk Krasang areas)	1,750
3. Saba reservoir plan area	500
Total	4,200

4.4.2 Water Supply Plan

(1) Available Water

Main irrigation water source to the Kandal Stung Study area is the runoffs of the Prek Thnot river, and it is taken at Kompong Tuol site from the right bank of the Prek Thnot river. The Study area lies most downstream of the Prek Thnot Multi-purpose Project area. The Prek Thnot irrigation schemes have been envisaged, having irrigation areas of 1,700 ha with run-of-river water according to the Reappraisal Report of Prek Thnot Multipurpose Project. The river discharges to be utilized for the Study area are to be the residual ones after sharing the river water to those irrigation schemes. As described in ANNEX-1, the available discharges are estimated on half-monthly basis, as presented in Table V-11 and are averaged as follows:

Unit: MCM

River	Jan.	Feb.	Mar.	Apr.	May.	Jun	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Prek Thnot	8	5	4	7	33	79	141	199	319	434	148	69	1,446

The river discharges decrease sharply from December, and the low flows continue through April. The irrigation area with the run-of-river water is quite limited.

A reservoir operation study of the Prek Thnot Multi-purpose dam has been performed in the Reappraisal Study and the result has indicated that, for a storage capacity of 1,120 MCM having a corresponding full supply level of 58.5 m, the net irrigation area would range from 35,000 ha without a firm power generation to 33,000 ha with a firm power generation of 2 MW. Therefore, ultimate irrigation development of suitable land in Kandal Stung area of 4,200 ha has to rely on the water resources development by the Prek Thnot reservoir.

(2) Irrigable Area

The irrigable area of the Kandal Stung Study area is 4,200 ha which consists of (1) the area of 3,700 ha to be commanded from the existing Kandal Stung intake and (2) the Saba reservoir plan area of 500 ha. The former is divided into the following areas, (i) the existing irrigation area of 1,950 ha, (ii) southern and northern areas of 1,750 ha in total .

i) Without Prek Thnot Reservoir Plan

In order to estimate the irrigation service areas under without Prek Thnot Reservoir, the water balance simulation was carried out between the supply and the demand for a series of ten (10) years from 1961 to 1970, for which the discharge data were made available. The simulation shows that the Kandal Stung area will be served for 1,950 ha from the Kompong Tuol regulator site under without Prek Thnot reservoir. The basic condition applied for the simulation is as follows:

a. Water allocation priority is given to the Kandal Stung area especially in the dry season since the Kandal Stung area has no possible local reservoir site.

b. Irrigable area under the run-of-river water is determined with an irrigation dependable level of 4 out of 5 years through half-monthly water balance simulation. The year 1968 is the basic design year according to the simulation.

The result is as shown in Fig.V-9 and summarised in Table V-12. The following is the water balance of the basic year 1968 on the monthly basis:

Unit : MCM

Description	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sep.	Oct.	Nov.
Qt	9	5	2	1	4	18	47	99	211	145	316	24
Qa	4	2	2	1	1	13	47	96	206	141	313	20
Wd	4	2	2	0	0	2	3	5	4	2	2	4
Sp	0	0	0	1	1	11	44	91	202	139	311	16

Note : Qt : Total discharges of the Prek Thnot river including tributaries
Qa : Available discharge to the Study area
Wd : Irrigation water demand of Kandal Stung area 1,950 ha
Sp : Surplus discharge

ii) With Prek Thnot Reservoir Plan

Reliable irrigation to the remaining area of 1,750 ha will not be ensured. If the Government of Cambodia intends to implement the above-mentioned without reservoir case as a first phase, the remaining area could be implemented only after realisation of the Prek Thnot reservoir as an extension area.

The Saba reservoir irrigation area is about 500 ha which lies between the Stung Toch river and Tonle Bati lake. The Saba lake has no significant catchment area for water storage, then supplemental water supply from the Prek Thnot is necessary. The cost required for irrigation and drainage system, mostly consisting of construction of Saba dam and a connection canal is high, compared with its service area. It leads to low economic efficiency. The water level of Saba reservoir will fluctuate largely in case of without Prek Thnot dam. Those imply low priority of development of this scheme.

Further, there exists a large extent of the farm land in the east and north of the Kandal Stung Study area (Kampoes, Siem Reap, Pr Sleng,etc.) but beyond the Study area. Judging from the topography and location of such farm land, they can be covered from the Kompong Tuol regulator site when the Prek Thnot reservoir has been created.

With a view to effective use of the facilities of the Kandal Stung Irrigation Project, the first stage development should be formulated in due consideration of the future land development potential. The soil conditions of the land outside the Study area is not confirmed, then, the extent is subject to the further soil survey. The following shows the irrigation area.

Development Area	Irrigable Area (ha)
Irrigable Area of Kandal Stung Study Area	
- without Prek Thnot reservoir condition	1,950
- additional area with Prek Thnot reservoir condition	2,250
Outside the Study area	
- north area	200
- east area	4,800
Total	9,200

(3) Water Supply Plan

The existing main canal has been implemented with improvement of old Pol Pot canal, and the design capacity at its head is 9.8 m^3/sec which is sufficiently large to command the possible irrigation area of the Kandal Stung area. The southern area will be served from Lateral No. 1 by provision of a new lateral canal. The northern area will be supplied from Lateral No. 2 through its extension. The preliminary canal layout of Kandal Stung Study area is as shown in Fig. V-10.

4.4.3 Drainage Plan

Most part of Kandal Stung is drained to Cheung Loung lake through the old Pol Pot canals on east-west direction. The northern part is directly drained to the Prek Thnot river also through the old Pol Pot canals.

The drainage canal system to be constructed consists of major drainage canals, and tertiary and quaternary canals and their related structures. The preliminary layout of drainage canal system is as shown in Fig. V-10. Major drainage canals will be constructed mainly by improvement of the old Pol Pot canals. Tertiary drainage canals within the tertiary blocks are improved/constructed together with the irrigation canal system.

4.4.4 General Features of Irrigation and Drainage Facilities

(1) General Design Consideration

According to the irrigation area determined, the preliminary designs for improvement of the existing canals and related structures are prepared for the irrigable area, including improvement of the existing system. The following works will be necessary:

i) Irrigation Canals

Canal sections of the existing main canal to tertiary canals are in poor shape due to slope sliding and erosion. To prevent collapse of the canal embankment and to save the future O & M cost, canal slope protection will be needed by means of 2-phase concrete lining. Most of canal embankments are also severely eroded and eroded soils are silted-up on the canal berms. Canal reshaping by earthfill and removal of sediment will be necessary. Main canal inspection road is not functioning due to erosion or breach of embankments. Laterite pavement will be provided for inspection road after re-shaping.

The following works are required for respective canals:

a. Main Canal

- Slope protection by means of 2 phase concrete lining, and sod facing,
- Re-shaping of canals cross sections with removal of sediment and earthfill for embankment,
- Improvement of canal embankment,
- Provision of inspection road with laterite pavement,
- Sod facing on the slope of canal embankment.

b. Laterals and Tertiary Canals

- Re-shaping of the existing canals cross sections by means of removal of sediment and earthfill for embankment,
- Improvement of canal embankment and inspection road,
- Sod facing on the slope of canal embankment,
- Construction of canals for extension area.

ii) Provision of Quaternary Canals

The commanding area of the existing tertiary canal ranges from 30 to 100 ha, averaged to 65 ha. Tertiary canals are provided in parallel at intervals of 500 m to 800 m. To

ensure equitable water delivery in the tertiary service area, the field ditch will be needed.

iii) Related Structures

The following structure improvement/construction will be needed.

- Installation of gates at the existing check structures, diversion structures and turnouts,
- Repair of canals sections downstream of structures slope protection,
- Provision of required structures or structure parts where not provided yet,
- Replacement of structures damaged severely.

iv) Improvement of Drainage Canals and Related Structures

- Provision of major drainage canal,
- Clearing and reshaping of major drainage canals,
- Reshaping of the tertiary drainage canals,
- Additional tertiary canals,
- Drainage structures where required.

(2) Proposed Project Works

The general features of the proposed project works of the irrigation and drainage system are as follows:

The improvement works of the existing irrigation canal system include the following:

Description		First Stage Work	Second Stage Work
Main canal			
- Improvement of main canal	(km)	5.3	0
Lateral			
- Improvement of existing lateral	(km)	8.2	0
- Construction of lateral	(km)	4.0	18.3
Tertiary canal			
- Improvement/construction of tertiary canal	(km)	56.8	65.5
Quaternary canal system	(ha)	1,950	1,750
Saba Scheme			
- Saba dam	(nos)	-	1
- Connection canal	(km)	-	4.5
- Lateral canal	(km)	-	8.0
- Tertiary canal	(km)	-	11.0
- Quaternary canal system	(ha)	-	500
Drainage works			
- Major drainage canals	(km)	18.1	20.9
- Tertiary canal	(km)	64.6	74.5