TABLES

Table 4.1 General Characteristics of Soil Groups

Soil Group	Physio-graphic unit	Land use	Soil color	Physical and chemical characteristics	% of paddy area in Cambodia
Prey Khmer soils	Alluvial/ collovial plain	Paddy field	Pale brawn or light gray	Deep sandy surface; low water-holding capacity; very poor nutrient and organic matter; acidic soil	11%
Prateah Lang soils	Old alluvial/ collovial plain or terrace	Paddy field	Pale brawn or light gray	Sandy topsoil, heavier subsoil; low water- holding capacity; very poor nutrient and organic matter; acidic soil	28%
Bakan soils	Depression of old alluvial/ collovial plain	Paddy field	Gray or light gray.	Medium texture topsoil, heavier subsoil; high water-holding capacity; poor drainage; Moderate nutrient and organic matter	13%
Koktrap soils	Alluvial plain	Paddy field	Dark gray or black soil	Heavy texture soil; high water-holding capacity; moderate nutrient and much organic matter	5%
Toul Samroung soils	Undulating alluvial/ collovial plain	Dry-crop and paddy field	Brown or gray	Heavy texture; high water-holding capacity; moderate nutrient; slightly acidic or neutral	10%
Kein Svay soils	Recent alluvial plain/ natural river levees	Paddy (rainy season, dry-crops (dry season)	Gray or brown	Medium to heavy texture; high water-holding capacity; good drainage; fertile soil, moderate organic matter	2%
Kbal Po soils	Recent alluvial plain	Paddy (dry season), flooded (rainy season)	Gray, brown, or dark gray	Heavy texture; flooded for 3 - 5 months; high water-holding capacity; fertile soil; moderate organic matter; acidic	13%
Krakor soils	Recent alluvial plain	Paddy (dry season), flooded (rainy season)	Gray, brown or dark gray	Heavy texture; flooded for 3 - 5 months; high water-holding capacity; fertile soil, moderate organic matter; acidic	12%
Labansiek soils	Undulating sloping hill land	Mainly dry-crop field	Red or reddish brown	Heavy texture; high water-holding capacity; moderate nutrient; slightly acidic or neutral	1%
Kompong Siem soils	Hill slopes	Mainly dry-crop field	Black or dark gray	Clay soil gravel and boulders; high water-holding capacity; fertile soil; neutral to slightly alkaline	2%

Source: "The Soils Used for Rice Production in Cambodia ~ A Manual for Their Identification and Management" and "Rice production in Cambodia"

Table 4.2 Crop Budget of Present Condition

(Unit: per ha)

Name of crop	Paddy	Condition:	Medium maturing paddy, Rain-fed		
		Unit	Quantity	Price (Riel)	Value (Riel)
A. Gross Income Total (A)					**496,600**
Main product		kg	1,300	370	481,000
By-products (straw)		kg	1,300	12	15,600
B. Direct Production Cost Total (B)					**196,843**
B.1 Input Cost Subtotal (B.1)					**97,130**
Seed		kg	65	420	27,300
Compost		m^3	2	8,000	16,000
Chemical fertilizer	Urea	kg	25	800	20,000
	DAP	kg	25	1,000	25,000
	KCL	kg	0	800	0
Agro-chemicals	Insecticide	kg, lit.	0	20,000	0
	Fungicide	kg, lit.	0	20,000	0
	Herbicide	kg, lit.	0	20,000	0
Others					8,830
B.2 Labor Cost Subtotal (B2)		man-day	**90**		**27,000**
Hired labor		man-day	9	3,000	27,000
Family labor		man-day	81	0	0
B.3 Draft Animal / Machinery Cost (Subtotal B.3)					**63,000**
Land preparation by animals		anim.-day	7	7,000	49,000
Land preparation by tractor		hour			
Thresher		hour			
Transportation		anim.-day	2	7,000	14,000
B.4 Tool / Equipment Cost					**9,713**
C. Indirect Cost Total (C)					**3,885**
Tax					0
Interest of credit					3,885
Irrigation service fee					0
Depreciation cost					0
D. Net Return D = A - (B + C)					**200,728**

Table 5.1 Daily Rainfall Record

Station: R0001 XXXXXX, Tram Kak, Takeo Province Location: 1326000 N, 438000 E (UTM)
Year: 1999 Owner MOWRAM

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	100.0	2.2	-	-	-	-	2.4	NA	12.4	34.1	9.4	-	
2	24.0	0.0	-	-	-	-	9.6	NA	1.1	54.2	2.3	-	
3	2.0	-	-	-	-	34.2	12.4	NA	2.4	12.3	45.0	-	
4	1.0	-	-	-	-	2.1	56.0	NA	3.6	43.1	12.3	-	
5	23.5	-	-	-	-	-	23.1	NA	8.3	0.0	-	-	
6	0.0	-	-	-	-	-	-	-	35.0	5.0	-	-	
7	0.0	-	-	-	-	-	-	2.4	47.0	9.7	-	-	
8	-	-	-	-	-	1.1	0.0	-	12.0	-	23.1	-	
9	2.3	-	-	-	-	-	12.4	3.5	0.0	-	12.4	-	
10	4.2	5.0	-	-	-	-	3.5	-	1.0	2.5	34.0	-	
11	0.0	1.2	-	-	-	-	-	34.7	37.0	12.4	1.2	-	
12	0.0	0.0	-	-	12.5	0.6	-	90.0	2.4	24.8	3.5	-	
13	0.0	-	-	-	21.3	-	2.1	11.4	5.1	3.1	0.1	-	
14	0.0	-	-	-	-	10.3	-	2.3	2.5	0.5	-	-	
15	-	-	-	-	-	-	0.0	-	0.0	0.0	-	-	
sub-total (1)	157.0	8.4	0.0	0.0	33.8	48.3	121.5	**NA**	169.8	201.7	143.3	0.0	
16	-	-	1.3	-	-	-	-	-	9.1	-	-	-	
17	-	-	12.4	-	-	-	32.0	-	23.5	23.1	23.0	-	
18	-	3.5	-	-	-	11.1	12.0	23.4	25.0	45.3	1.7	-	
19	-	21.2	-	-	-	-	11.1	12.4	-	-	-	-	
20	-	2.3	-	-	-	2.0	8.0	-	-	-	5.1	-	
21	-	0.0	-	-	-	-	4.2	2.4	-	6.7	-	-	
22	-	-	-	12.4	-	1.3	-	123.0	-	34.1	-	-	
23	2.0	-	-	0.0	-	2.5	0.0	45.2	12.5	-	-	-	
24	0.5	-	-	-	-	6.7	2.4	8.6	70.0	2.5	2.3	-	
25	-	-	-	-	-	8.1	19.0	22.3	-	12.8	23.0	-	
26	-	-	0.0	-	-	12.4	34.0	34.0	2.3	7.9	-	-	
27	-	-	-	-	-	25.0	11.3	0.0	-	-	1.7	-	
28	-	-	-	12.1	-	28.0	-	13.0	0.7	2.3	23.0	-	
29	-		-	-	-	80.0	-	12.0	60.0	0.6	66.0	-	
30	2.1		-	-	-	-	1.3	2.3	12.0	57.2	5.8	-	
31	0.0		-		-		9.8	5.1		3.0		-	
sub-total (2)	4.6	27.0	13.7	24.5	0.0	177.1	145.1	303.7	215.1	195.5	151.6	0.0	
total	161.6	35.4	13.7	24.5	33.8	225.4	266.6	**NA**	384.9	397.2	294.9	0.0	**NA**
max.	100.0	21.2	12.4	12.4	21.3	80.0	56.0	**NA**	70.0	57.2	66.0	0.0	**NA**
min.	0.0	0.0	0.0	0.0	12.5	0.6	0.0	**NA**	0.0	0.0	0.1	0.0	**NA**
rain days	17	9	3	3	2	15	22	**NA**	24	24	19	0	**NA**

Data not available

rainfall not measurable

no rainfall

Even with one "NA", total, maximum, minimum, and rain days should be "NA"

Table 5.2 Monthly Rainfall Record

Station: R0001 XXXXXX, Tram Kak, Takeo Province Location: 1326000 N, 438000 E (UTM)
Year: 1999 Owner MOWRAM

Year:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1986	100.0	23.0	12.0	2.1	0.0	**12.5**	125.6	450.0	231.0	281.2	14.2	11.5	1263.1
1987	24.0	12.0	2.3	0.0	12.3	67.9	45.2	234.0	**111.2**	33.5	45.1	3.5	591.0
1988	**23.5**	**2.4**	4.5	12.5	2.0	125.4	34.6	125.7	312.4	213.2	23.1	12.0	891.3
1989	56.8	35.6	33.2	23.5	12.7	12.0	78.9	640.1	12.4	135.0	152.9	0.0	1193.1
1990	123.2	78.1	0.0	11.0	23.0	6.8	52.3	234.5	231.0	512.0	230.1	**2.3**	1504.3
1991	54.1	12.0	0.0	4.5	1.4	33.5	12.3	211.3	298.4	221.0	11.0	0.0	859.5
1992	23.1	3.4	3.0	0.0	7.0	23.9	145.0	80.5	342.8	123.0	234.0	45.2	1030.9
1993	5.1	56.1	2.3	23.2	1.1	89.3	77.0	67.8	319.4	89.7	43.2	0.0	774.2
1994	34.5	23.0	**1.5**	34.0	0.0	12.5	**34.6**	411.2	223.0	45.3	35.6	123.0	978.2
1995	450.8	0.0	13.2	23.8	3.5	35.8	67.2	23.5	76.4	23.6	123.4	23.4	864.6
1996	24.2	2.3	45.0	90.0	0.0	178.9	34.5	297.5	294.3	319.3	**21.5**	12.5	1320.0
1997	3.1	26.7	11.2	2.1	**1.0**	23.0	9.3	512.4	422.4	98.2	11.5	44.2	1165.1
1998	289.4	1.3	34.0	1.0	2.5	66.7	128.4	23.5	129.0	129.4	41.5	32.5	879.2
1999	100.0	145.3	0.0	4.5	31.0	23.4	205.0	NA	312.5	222.1	23.1	5.9	NA
2000	234.1	23.0	111.0	**2.0**	12.5	99.0	45.0	308.9	98.9	**78.0**	223.0	123.0	1358.4
average	103.1	29.6	18.2	15.6	7.3	54.0	73.0	NA	227.7	168.3	82.2	29.3	NA
R80	23.5	2.4	1.5	2.0	1.0	12.5	34.6	NA	111.2	78.0	21.5	2.3	NA
max.	450.8	145.3	111.0	90.0	31.0	178.9	205.0	NA	422.4	512.0	234.0	123.0	NA
min.	3.1	0.0	0.0	0.0	0.0	6.8	9.3	NA	12.4	23.6	11.0	0.0	NA

Even with one "NA", total, maximum, minimum, and rain days should be "NA"

Monthly rainfall of 80% dependability.
If data are available for "n" years, **{(n/5)+1}th smallest** monthly rainfall would be R80.
R80 is given with "bold face" for each month.

Table 5.3 Test Results of Water Quality Analysis

Parameter	Unit	River			WHO	Standard Value[*2]	
		P1	P2	P3	Guideline[*1]	River	Lake/Reservoir
Air Temperature	℃	27.0	27.0	27.0	-	-	-
Conductivity	ms/cm	110.0	98.3	99.7	-	-	-
pH Value	Unit	7.50	7.52	7.73	6.5 - 8.5	6.5 - 8.5	6.5 - 8.5
Total Dissolved Solids (TDS)	mg/L	100	87	67	1000	-	-
Suspended Solids (TSS)	mg/L	57.3	119.3	86.7	-	25 - 100	1 - 15
Aikalinity (as $CaCO_3$)	mg/L	66	40	58	-	-	-
Calcium (Ca)	mg/L	7.4	3.8	7.1	-	-	-
Magnesium (Mg)	mg/L	3.3	1.0	2.2	-	-	-
Total Hardness (Ca+Mg)	mg/L	31.9	13.5	26.7	500	-	-
Chloride (Cl)	mg/L	0.9	1.4	0.8	250	-	-
Fluoride (F)	mg/L	0.20	2.30	0.10	1.5	-	-
Copper (Cu)	mg/L	0.0	0.0	0.0	2	-	-
Iron (Fe)	mg/L	1.63	2.23	1.59	0.3	-	-
Manganese (Mn)	mg/L	0.30	0.10	0.10	0.1	-	-
Nitrate (NO_3-N)	mg/L	0.2	0.0	0.0	10	-	-
N-Amonia (NH_4-N)	mg/L	0.23	0.66	0.55	1.5	-	-
Potassium (K)	mg/L	1.50	1.90	1.80	-	-	-
E-Coli	cfu/1000ml	330	620	570	0	-	-
Total Coliforms	cfu/1000ml	2000	8400	2000	0	<5000	<1000
Fecal Coliforms	cfu/1000ml	70	0	150	0	-	-
COD_{Mn}	mg/L	2.3	7.4	3.0	-	-	1 - 8
BOD	mg/L	33.0	16.0	22.0	-	1 - 10	-

*1: WHO guideline for drinking water quality

*2: Water quality standard in public water areas for bio-diversity conservation (Sub-decree on Water Pollution Control, 1999, RGC)

Table 6.1 Location and Number of Sampling

Stage / Type	Preliminary Investigation	Detailed Investigation	
		Soft Ground Investigation	Permeable Ground Investigation
Boring	Location 1 location / 200m along the center line of the dike Depth 3 times of height of the dike Main Purpose Confirmation of N-value and permeability. Sampling of disturbed materials	Location 1 location / 100m along the center line of the dike Depth Up to the depth of the soft ground layer that might affect the stability of the dike Main Purpose Sampling of disturbed materials	Location 1 cross-section / 100m along the center line of the dike. One location each at foot of embankment (upstream side and down stream side) Depth Up to the continuous non-permeable layer, or up to 20 m. Main Purpose Sampling, Permeability test
Sounding Test	Location 1 location /50~100m along the center line of the dike.	Location 1 location / 20~50m along the center line of the dike. Depth Up to the depth of the soft ground layer that might affect the stability of the dike	Location 1 location / 100m along the center line of the dike. 1 location / 20~50m across the center line.
Sampling		Location 1 sample / 100m along the center line of the dike 1 sample per 2 m depth or 1 sample per layer if the changes of layers are remarkable.	Location 1 cross-section / 100m along the center line of the dike. One location each at foot of embankment (upstream side and down stream side) 1 sample per 2 m depth or 1 sample per layer if the changes of layers are remarkable.
In Situ Permeability Test	1 location per bore hole		Location 1 cross-section / 100m along the center line of the dike. One location each at foot of embankment (upstream side and down stream side) 1 sample per layer.
Soil Mechanical Test		1 sample per 2 m depth or 1 sample per layer if the changes of layers are remarkable.	1 sample per 2 m depth or 1 sample per layer if the changes of layers are remarkable.

Table 7.1 Database on the Canal Inventory Survey

Code	Serial No	Line No.	Total L (m)	Purpose	Landuse		UTM Coordinate		Up/Downstream - 1						Up/Downstream - 2					
					Left	Right	East	North	B (m)	b (m)	H (m)	h (m)	Serious Problems	Evaluation	B (m)	b (m)	H (m)	h (m)	Serious Problem	Evaluation
A	1	C1I	8,800.00	IGT	V	V	54026	9987	6.20	3.00	1.70	0.20	SD,ITR	C						
A	2	C1I	8,800.00	IGT	PF	PF	54308	9989	2.50	2.00	0.60	0.00	SD	C						
A	3	C1I	8,800.00	IGT	PF	PF	54574	9991	2.00	2.00	0.50	0.00	SD	C						
A	4	C1I	8,800.00	IGT	PF	PF	54952	9988	5.00	4.00	1.00	0.40	SD	C	3.00	2.00	0.50	0.00	SD	C
A	5	C1I	8,800.00	IGT	PF	PF	55469	10004	4.00	3.00	0.90	0.00	SD	C	3.00	2.00	0.90	0.00	SD	C
A	6	C1I	8,800.00	IGT	PF	PF	55888	10012	2.50	2.00	0.60	0.00	SD	C						
A	7	C1I	8,800.00	IGT	PF	PF	56348	10017	5.00	3.00	1.00	0.00	SD	C						
A	8	C1I	8,800.00	IGT	PF	PF	56861	10027	5.00	3.00	1.00	0.00	SD	C						
A	9	C1I	8,800.00	IGT	PF	PF	57332	10037	3.00	2.00	1.00	0.00	SD	C						
A	10	C1I	8,800.00	IGT	PF	V	57956	10047	5.00	1.50	1.50	0.00	SD,ITR	C						
A	11	C1I	8,800.00	IGT	PF	PF	58370	9991	3.00	1.50	1.00	0.00	SD,ITR	C						
A	12	C1I	8,800.00	IGT	PF	PF	58650	10010	4.00	4.00	0.50	0.00	SD,ITR	C						
A	13	C1I	8,800.00	IGT	PF	PF	59150	10071	4.00	4.00	0.50	0.00	SD,ITR	C						
A	14	C1I	8,800.00	IGT	PF	PF	59536	10081	3.00	1.50	1.00	0.00	SD,ITR	C						
A	15	C1I	8,800.00	IGT	PF	PF	60194	10098	5.00	3.00	1.00	0.00	SD,ITR	C	4.00	2.00	0.80	0.00	SD,ITR	C
A	16	C1I	8,800.00	IGT	PF	V	60617	10109	4.00	2.00	1.00	0.00	SD,ITR	C						
A	17	C1I	8,800.00	IGT	V	PF	61023	10111	4.00	2.50	1.00	0.00	SD,ITR	C	3.00	2.00	1.00	0.00	SD,ITR	C
A	18	C1I	8,800.00	IGT	PF	PF	61423	10112	4.00	2.00	1.00	0.00	SD,ITR	C						
A	19	C1I	8,800.00	IGT	PF	PF	61852	10114	4.00	2.00	1.00	0.00	NO	B						
A	20	C1I	8,800.00	IGT	PF	PF	62220	10112	3.00	2.00	1.00	0.00	SD,LK,ITR	C						
A	21	C1I	8,800.00	IGT	PF	PF	62577	10142	3.00	3.00	0.20	0.00	NO	C						
A	22	C1I	8,800.00	IGT	PF	PF	62734	10129	3.00	2.00	0.30	0.00	LK,ITR	C						
A	23	CO	9,200.00	IGT	V	PF	40714	29269	18.00	5.00	3.00	1.00	ITR	B						
A	24	CO	9,200.00	IGT	PF	PF	40756	28811	18.00	10.00	3.50	0.00	LK,ITR	C						
A	25	CO	9,200.00	IGT	PF	PF	40846	28283	17.00	10.00	2.00	0.00	SD,LK,ITR	C						
A	26	CO	9,200.00	IGT	PF	PF	40979	27472	20.00	12.00	2.00	0.00	ITR	C						
A	27	CO	9,200.00	IGT	PF	PF	41136	26883	20.00	12.00	2.20	0.00	ITR	C						
A	28	CO	9,200.00	IGT	PF	PF	41681	26310	20.00	12.00	2.10	0.80	LK,ITR	C						
A	29	CO	9,200.00	IGT	PF	PF	42003	25886	18.00	4.00	3.50	0.10	SD,LK,ITR	C						
A	30	CO	9,200.00	IGT	V	PF	42751	25276	7.00	4.00	1.80	0.90	SD	C						

Note

A : Fully functioning
B : Partly deteriorated ,but functioning in a satisfactory range
C : Not functioning well and/or affecting the downstream flo
D : Completely not functioning.
PF : Paddy field.

V : Village.
PO : Pond.
RE : Reservoir.
PA : Pagoda.
BS : Basin

IGT : Irrigation.
SD : Sediments.
LK : Leakage.
ITR : Inspection road.
W : Water

NO : None
RD : Road
S : School

Table 8.1 Minutes of Meeting

Meeting No.:	**Date:**	**Village:**
3rd	4 Sep. 2001	Trapeang Chhuk T.T.K. Tboung Commune

Participants
Village: Chief and vice-chief of village, villagers (9 male and 5 female)
JICA: Mr. ITAYA, Mr. Karona and Mr. Sophal

Main object	**Results**
● Collection of landholding data inside small reservoir. ⇒	Summarized in attached table. 14 HH have land in small reservoir. They agree for rehabilitation of small reservoir.

Other discussion/Finding	
● Villager	I request for JICA to rehabilitate farm road in the village. They need equipments and some pipe.
● Karona	You will be able to request to the project through chief of village.
● Villager	I want to work as labor for not only SRP but also USP and other constructions.
● Karona	If the project (contractor) need labor, you will be able to work.
● Villager	How can we plant paddy in the reservoir after receding water from the Ang 160 reservoir?
● Karona	It should be decide by each FWUC. Discuss with FWUC member, please.
● Villager	If we can plant paddy in the reservoir after receding water, do we have to pay ISF?
● Karona	It should be decide by each FWUC and upper organization of FWUC.
● Villager	Please irrigate his land locating far from the small reservoir using the small reservoir's water.
● Karona	I am not sure.
Next meeting:	AM 9:00, 11 Sep. 2001

Table 11.1 Water Quality Standard

Items	Irrigation Water Standard						Other Standard		
	FAO					Japan	Drinking Water (WHO)	Sub-decree of RGC[*3]	
	Degree of Restriction Use								
	None	Slight to Moderate	Severe	Max. Concent.	Usual range in irri.	No restrection		River	Lake/ Reservoir
Electric Conductivity (EC) [*1]	<0.7dS/M	0.7-3.0dS/m	>3.0dS/m		0-3dS/m	≤0.3ms/cm			
pH Value [*1]	Normal range 6.5-8.4				6.0-8.5	6.0-7.5	6.5 - 8.5	6.5 - 8.5	6.5 - 8.5
Color [*1]							15TCU [*4]		
Total Dissolved Solids (TDS) [*1]	<450mg/l	450-2000mg/l	>2000mg/l		0-2000mg/l		1000mg/l [*4]		
Suspended Solids (TSS)						≤100mg/l		25 - 100mg/l	1 - 15mg/l
Sodium (Na) [*1]	<3me/L [*2]	3-9me/L [*2]	>9me/L [*2]		0-40me/L		200mg/l [*4]		
Calcium (Ca) [*1]					0-20me/L				
Magnesium (Mg)					0-5me/L				
Total Hardness (Ca+Mg)							500mg/l		
Chloride (Cl) [*1]	<4me/L [*2]	4-10me/L [*2]	>10me/L [*2]		0-30me/L		250mg/l [*4]		
Fluoride (F) [*1]				1.0mg/l			1.5mg/l		
Boron (B)	<0.7mg/l	0.7-3.0mg/l	>3.0mg/l		0-2mg/l		0.5mg/l		
Arsenic (As) [*1]				0.1mg/l		≤0.05mg/l	0.01mg/l	<0.01mg/l	<0.01mg/l
Copper (Cu) [*1]				0.2mg/l		≤0.02mg/l	2mg/l		
Iron (Fe) [*1]				1.0mg/l			0.3mg/l		
Zinc (Zn) [*1]				2.0mg/l		≤0.5mg/l	3mg/l		
Manganese (Mn) [*1]				0.2mg/l			0.5mg/l		
Nitrate Nitrogen (NO_3-N) [*1]	<5mg/l	5-30mg/l	>30mg/l		0-10mg/l		50mg/l		
Nitrite Nitrogen (NO_2-N) [*1]							3mg/l		
Ammo. Nitorogen (NH_4-N)					0-5mg/l		1.5mg/l [*4]		
Total Nitrogen (T-N)						≤1mg/l			0.1-0.6mg/l
Potassium (K) [*1]					0-2mg/l				
Bacteria [*1]							0 /100ml		
Coliform Group [*1]							0 /100ml	<5000 /100ml	<1000 /100ml
DO						≥5mg/l		2.0-7.5mg/l	2.0-7.5mg/l
COD_{Mn}						≤6mg/l			1 - 8
BOD								1 - 10	

*1: Items recommended to be checked in Subsection 5.3.4 of Chapter 5

*2: Except sprinkler irrigation

*3: Water quality standard in public water areas for bio-diversity conservation (Sub-decree on Water Pollution Control, 1999, RGC)

*4: Values which may give rise to complains from consumers

Table 12.1 Items of Examination for Selection of Target Crops

Characteristics of Candidate Crops	
Water requirement	Paddy rice requires more water than diversified crops
Droughty and wet tolerance	Resistant capacity for dry or wet condition
Photo- sensitivity	If photo-periodic sensitive crop, planting period is limited
Growing period	Period between sowing and harvesting. If transplanting, both periods of nursery and main filed.
Suitability for Climatic Conditions	
Temperature	Range of suitable air temperature
Rainfall and air humidity	Can be used rainfall effectively? Influences of rainfall to harvesting and crop drying, heavy rain to crop growing, and. high humidity to serious pest damage.
Suitability for Soil and Land Conditions	
Soil chemical properties	To examine soil chemical properties by laboratory analysis.
Soil water condition	Permeability and water-storage capacity
Soil texture	Soil texture affects soil fertility, water permeability, workability for soil plowing, and drainability.
Easiness of tilling	Easiness of tilling is an essential factor for farming by labor and animal work, especially for diversified crops
Drainability and flood	Poor drain land are generally not suitable for diversified crops
Farmers intension and willingness	
Intention to crop	Farmers intention to paddy varieties: high yielding or local
Level of farming skill	Farmers technical level and familiarity with the crop
Socio-economic Conditions	
Labor and draft animal requirement	To examine available labor force and draft animal against the requirements, and to examine mechanization, if not enough to the requirement,
Availability of inputs required	Required inputs are available in market?
Profitability of crop	Profit of crop per
Inputs cost and financial capacity of farmers	To examine value of inputs and financial situation of farmers in the project area
Marketability of products	
Target consumers market	In and around project area, rural market, large city market, or international market
Processing facility	Location/distance to processing facility, and processing capacity
Supply-demand balance	To examine supply and demand of target market, and fluctuation of seasonable market prices.
Transportation	Distance to target market, transportation cost, activity of traders and handling cost
Possibility of storing	Location and capacity of storage
Competition with other producing area	Price, quality, and marketing capacity of other producing area. Marketing ability of producers in the project area

Table 12.2 A Sample of Selection of Target Crops

Candidate crop		Early Paddy	Medium Paddy	Maize	Soybean	Watermelon	Vegetable
Selected target crop		○	○		○		○
Water requirement		High	High	Medium	Low	Low	Low
Growing period	day	105 included 30 nursery period	120 included 30 nursery period	95	85	95 included 20 nursery period	80
Photo-sensitivity		No	Some varieties	No	No	No	No
Climatic suitability		Good, but no good for harvesting in heavy rainy season	Good, but no good for harvesting in heavy rainy season	Good	Good except hevey rainy season	Good except hevey rainy season	Good except heavy rainy season
Suitabiity for soil / land condition		Good	Good	Good	Good except poor drain land	Good except poor drain land	Good except poor drain land
Farmers intention		Moderate	High	Moderate	Low	Moderate	High
Farmers skill level of farming		Moderate	Moderate	Low	Low	Moderate	Low
Labor requirement	man-day /ha	85	85	65	65	100	120
Availability of labor and draft animal		Enough	Enough	Enough	Enough	Enough	Enough
Availability of inputs		Deficit of certified seed	Deficit of certified seed	Available	Available	Deficit of improved variety seed	Available
Anticipated yield	ton/ha	3.5	3.0	1.3	1.0	8.0	7.0
Unit price of product	Riel/kg	330	370	720	1200	400	600
Gross income	Riel/ha	1,155,000	1,110,000	936,000	1,200,000	3,200,000	4,200,000
Cost of inputs		Moderate	Moderate	Low	Low	High	High
Profitability		Low	Moderate	Low	Moderate	High	High
Target market		In and around Project area	In and around Project area	In and around Project area	In and around Project area	Town market	Phnom Penh market
Distance to market	km	5	5	5	5	15	60
Processing facility		Sufficient rice mills	Sufficient rice mills	No	No	-	-

Table 12.3 A Sample of Crop Budget

Proposed (With-Project)

Name of crops		Paddy local			Paddy HYV			Maize			Bean			Vegetables		
	Unit	Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value 1000Riel
1 Gross Income	**Riel**			**1,036**			**1,089**			**1,080**			**1,440**			**3,500**
Main products	kg	####	370	1,036	####	330	1,089	####	600	1,080	####	1,200	1,440	####	500	3,500
2 Direct Cost	**Riel**			**405**			**405**			**257**			**382**			**788**
2.1 Inputs	**Riel**			**281**			**281**			**174**			**300**			**663**
Seed	kg	65	400	26	65	400	26	20	2,000	40	30	4,500	135	6	#####	138
Farm manure (wet)	ton	3	#####	75	3	#####	75	0	#####	0	0	#####	0	5	#####	125
Fertilizer Urea	kg	100	800	80	100	800	80	80	800	64	80	800	64	150	800	120
DAP	kg	50	1,000	50	50	1,000	50	30	1,000	30	50	1,000	50	100	1,000	100
KCL	kg	30	800	24	30	800	24	30	800	24	30	800	24	100	800	80
Agro-chemicals	liter	0		0	0		0	0		0	0		0	4	#####	40
Others				26			26			16			27			60
2.2 Labor	**m-d**	**90**		**27**	**90**		**27**	**80**		**12**	**65**		**10**	**120**		**8**
Hired labor	**m-d**	**9**	3,000	**27**	9	3,000	**27**	4	3,000	**12**	3	3,000	**10**	3	3,000	**8**
Family labor	m-d	81	0	0	81	0	0	76	0	0	62	0	0	117	0	0
2.3 Draft animal	**Riel**			**63**			**63**			**49**			**39**			**46**
Land preparation	anml-d	7.0	7,000	49	7.0	7,000	49	5.0	7,000	35	4.0	7,000	28	5.0	7,000	35
Transportation	anml-d	2.0	7,000	14	2.0	7,000	14	2.0	7,000	14	1.5	7,000	11	1.5	7,000	11
2.4 Tool/Equipment	**Riel**			**34**			**34**			**22**			**34**			**71**
3 Indirect Cost	**Riel**			**61**			**58**			**37**			**50**			**86**
Water fee	Riel			3			0			0			0			0
Land fee	Riel			30			30			20			20			20
Tax	Riel			0			0			0			0			0
Interest	Riel			28			28			17			30			66
4 Total Cost	**Riel**			**466**			**463**			**294**			**432**			**874**
5 Profit	**Riel**			**570**			**626**			**786**			**1,008**			**2,626**
Profit ratio	**%**			**122%**			**135%**			**267%**			**233%**			**300%**

Present (Without-Project)

Name of crops		Paddy local			Paddy HYV			Maize			Bean			Vegetables		
	Unit	Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value (1000Riel)	Q'ty	Price (Riel)	Value 1000Riel
1 Gross Income	**Riel**			**481**			**429**			**540**			**585**			**2,000**
Main products	kg	####	370	481	####	330	429	900	600	540	450	1,300	585	####	500	2,000
2 Direct Cost	**Riel**			**208**			**208**			**146**			**233**			**510**
2.1 Inputs	**Riel**			**105**			**105**			**84**			**163**			**415**
Seed	kg	65	400	26	65	400	26	20	2,000	40	30	4,500	135	6	#####	138
Farm manure (wet)	ton	1	#####	25	1	#####	25	0	#####	0	0	#####	0	5	#####	125
Fertilizer Urea	kg	30	800	24	30	800	24	20	800	16	10	800	8	80	800	64
DAP	kg	20	1,000	20	20	1,000	20	20	1,000	20	5	1,000	5	50	1,000	50
KCL	kg	0	800	0	0	800	0	0	800	0	0	800	0	0	#####	0
Agro-chemicals	liter	0		0	0		0	0		0	0		0	0		0
Others				10			10			8			15			38
2.2 Labor	**m-d**	**80**		**24**	**80**		**24**	**70**		**0**	**60**		**0**	**100**		**0**
	m-d	**8**	3,000	**24**	8	3,000	**24**	0	3,000	**0**	0	3,000	**0**	0	3,000	**0**
	m-d	72	0	0	72	0	0	70	0	0	60	0	0	100	0	0
2.3 Draft animal	**Riel**			**63**			**63**			**49**			**49**			**49**
Land preparation	anml-d	7.0	7,000	49	7.0	7,000	49	5.0	7,000	35	5.0	7,000	35	5.0	7,000	35
Transportation	anml-d	2.0	7,000	14	2.0	7,000	14	2.0	7,000	14	2.0	7,000	14	2.0	7,000	14
2.4 Tool/Equipment	**Riel**			**17**			**17**			**13**			**21**			**46**
3 Indirect Cost	**Riel**			**10**			**10**			**8**			**16**			**41**
Water fee	Riel			0			0			0			0			0
Land fee	Riel			0			0			0			0			0
Tax	Riel			0			0			0			0			0
Interest	Riel			10			10			8			16			41
4 Total Cost	**Riel**			**219**			**219**			**154**			**249**			**552**
5 Profit	**Riel**			**262**			**210**			**386**			**336**			**1,448**
Profit ratio	**%**			**120%**			**96%**			**250%**			**135%**			**263%**

Table 12.4 A Sample on Calculation of Required Inputs

	Per ha					Project Area					
			Fertilizer		Agro-	Planted			Fertilizer		Agro-
	Seed kg	Urea kg	DAP kg	KCL kg	Chemicals liter	area ha	Seed ton	Urea ton	DAP ton	KCL ton	chemicals liter
Proposed (With-project)											
Paddy local	65	100	50	30	0	1,000	65	100	50	30	0
Paddy HYV	65	100	50	30	0	200	13	20	10	6	0
Paddy total						1,200	78	120	60	36	0
Maize	20	80	40	30	0	120	2	10	5	4	0
Bean	30	50	50	30	0	180	5	9	9	5	0
Vegetables	6	150	100	100	4	60	0	9	6	6	240
Total						1,560	6	18	15	11	240
Present (With-project)											
Paddy local	65	30	20	0	0	950	62	29	19	0	0
Paddy HYV	65	30	20	0	0	180	12	5	4	0	0
Paddy total						1,130	73	34	23	0	0
Maize	20	20	20	0	0	60	1	1	1	0	0
Bean	30	10	10	0	0	30	1	0	0	0	0
Vegetables	6	80	50	0	0	10	0	1	1	0	0
Total						1,230	1	1	1	0	0
Incremental											
Paddy local	0	70	30	30	0	50	3	72	31	30	0
Paddy HYV	0	70	30	30	0	20	1	15	6	6	0
Paddy total	0	0	0	0	0	70	5	86	37	36	0
Maize	0	60	20	30	0	60	1	8	4	4	0
Bean	0	40	40	30	0	150	5	9	9	5	0
Vegetables	0	70	50	100	4	50	0	8	6	6	240
Total						330	5	17	14	11	240

Table 12.5 A Sample of Examination of Labor Balance

	Planted area (ha)	Labor Requirement (man-day/month)												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Per ha (man-day/ha)														
Paddy local	1,000	5					4	12	15	16	7	15	16	90
Paddy HYV	200	7						5	16	18	6	20	18	90
Maize	120					8	19	15	19	19				80
Bean	180	10	25									15	15	65
Vegetables	60	10	10	10		10	15	10	15	10		15	15	120
Project area (1000 man-day)														
Paddy local	1,000	5.0	0.0	0.0	0.0	0.0	4.0	12.0	15.0	16.0	7.0	15.0	16.0	90.0
Paddy HYV	200	1.4	0.0	0.0	0.0	0.0	0.0	1.0	3.2	3.6	1.2	4.0	3.6	18.0
Maize	120	0.0	0.0	0.0	0.0	1.0	2.3	1.8	2.3	2.3	0.0	0.0	0.0	9.6
Bean	180	1.8	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	2.7	11.7
Vegetables	60	0.6	0.6	0.6	0.0	0.6	0.9	0.6	0.9	0.6	0.0	0.9	0.9	7.2
Total (a)	1,560	8.8	5.1	0.6	0.0	1.6	7.2	15.4	21.4	22.5	8.2	22.6	23.2	####
Available labor force * (b)		49.1	49.1	49.1	49.1	49.1	49.1	49.1	49.1	49.1	49.1	49.1	49.1	####
Balance (b-a)		40.3	44.0	48.5	49.1	47.6	42.0	33.7	27.8	26.7	40.9	26.5	25.9	####
(a/b)		0.18	0.10	0.01	0.00	0.03	0.15	0.31	0.44	0.46	0.17	0.46	0.47	0.23

Note *: Estimated at assumption of followings

Beneficiaries households	h.h.	####
Average family size	person/h.h	5.2
Average labor force per household	person/h.h	2.1
Labor force in the project area	person	####
Available labor force for on-farm work (80% for male, 50% for fer	%	65%
Workable days for on-farm work per month	day/momth	24
Available labor force for on-farm work per month	1000 man-day	49.1

Table 12.6 Prospective Crop Production

(Unit: ha)

	Planted area ha	Unit yield kg/ha	Production ton
Peoposed (With-Project)			
Paddy local	1,000	2,800	2,800
Paddy HYV	200	3,300	660
Paddy total	1,200		3,460
Maize	120	1,800	216
Bean	180	1,200	216
Vegetables	60	7,000	420
Total	1,560		
Present (Without-Project)			
Paddy local	950	1,300	1,235
Paddy HYV	180	1,300	234
Paddy total	1,130		1,469
Maize	60	900	54
Bean	30	450	14
Vegetables	10	4,000	40
Total	1,230		
Incremental			
Paddy local	50	1,500	1,565
Paddy HYV	20	2,000	426
Paddy total	70		1,991
Maize	60	900	162
Bean	150	750	203
Vegetables	50	3,000	380
Total	330		

Table 12.7 A Sample of Production Value and Incremental Net Return

	Per ha (1000 Riel/ha)					Project Area (million Riel)						Farmer of Average Farm Size (0.8ha) (1000Riel/households)					
	Gross income	Production cost			Net return	Planted area (ha)	Gross income	Production cost			Net return	Planted area (ha)	Gross income	Production cost			Net Return
		Direct	Indirect	Total				Direct	Indirect	Total				Direct	Indirect	Total	
Proposed (With-project)																	
Paddy local	1,036	405	61	466	570	1,000	1,036	405	61	466	570	0.67	691	270	41	311	380
Paddy HYV	1,089	405	58	463	626	200	218	81	12	93	125	0.13	145	54	8	62	83
Paddy total						1,200	1,254	486	73	559	695	0.80	836	324	48	372	463
Maize	1,080	257	37	294	786	120	130	31	4	35	94	0.08	86	21	3	24	63
Bean	1,440	382	50	432	1,008	180	259	69	9	78	181	0.12	173	46	6	52	121
Vegetables	3,500	788	86	874	2,626	60	210	47	5	52	158	0.04	140	32	3	35	105
Total						1,560	1,853	633	91	724	1,129	1.04	1,235	422	61	483	752
Present (With-project)																	
Paddy local	481	208	10	218	263	950	457	198	10	207	250	0.63	305	132	6	138	167
Paddy HYV	429	208	10	218	211	180	77	37	2	39	38	0.12	51	25	1	26	25
Paddy total						1,130	534	235	11	246	288	0.75	356	157	8	164	192
Maize	540	146	8	154	386	60	32	9	0	9	23	0.04	22	6	0	6	15
Bean	585	233	16	249	336	30	18	7	0	7	10	0.02	12	5	0	5	7
Vegetables	2,000	510	41	551	1,449	10	20	5	0	6	14	0.01	13	3	0	4	10
Total						1,230	604	256	13	269	336	0.82	403	171	8	179	224
Incremental																	
Paddy local	555	197	51	248	307	50	579	207	52	259	320	0.03	386	138	34	173	213
Paddy HYV	660	197	48	245	415	20	141	44	10	53	87	0.01	94	29	7	36	58
Paddy total						70	720	251	61	312	407	0.05	480	167	41	208	272
Maize	540	111	29	140	400	60	97	22	4	26	71	0.04	65	15	3	17	47
Bean	855	149	34	183	672	150	242	62	9	70	171	0.10	161	41	6	47	114
Vegetables	1,500	278	45	323	1,177	50	190	42	5	47	143	0.03	127	28	3	31	95
Total						330	1,248	377	79	456	793	0.22	832	251	52	304	529

Table 13.1 Target Level and Standard of Rehabilitation and Reconstruction of Irrigation and Drainage System (1/2)

Item	Target Level and Standard
Irrigation Plan	
● Irrigation method	Water saving irrigation method. Continuous distribution for the main and secondary canal. Rotational irrigation for tertiary and water courses.
● Dependability	80 % dependability (designed irrigation water supply is guaranteed for 4 years out of 5 years)
Reservoir	
● Design flood	Reservoir on the perennial river → 1 in 100 year flood or the maximum flood in the past. Small reservoirs (catchment area less than 10 km^2, or total storage capacity is less than 50,000 m^3) → 1 in 20 year flood.
● Dike	Height of dike should be basically maintained at no more than 5 m for stability. Earth materials are used. Typical section is shown in Fig 13.1 and 13.2.
● Intake Structure	Gate should be operated manually. Gate size should be determined taking maneuverability into account. Gate sill elevation would coincide with estimated dead storage elevation after 20 years of operation.
● Spillway	Overflow-type spillway would be the main spillway. Operation gate should be installed for maintenance of dike and reservoir and river flow.
● Freeboard	0.90 m. 0.60 m for small reservoirs (catchment area less than 10 km^2, or total storage capacity is less than 50,000 m^3)
● Sedimentation	Standard unit sedimentation rate : 0.1 mm/km^2/year. Sedimentation for 20 years would be considered as dead storage.
Irrigation canals	
● Canal network	Main canal, secondary canal, tertiary canal, water course. A tertiary block should be located in a village with area about 50 ha. The maximum length of the tertiary canal should be less than 1 km. The tertiary canal should have sufficient capacity for rotational irrigation.
● Lining	Earth-lined canal (Manning's roughness coefficient = 0.025) Typical canal section is given in Fig 13.3
● Existing capacity	Existing capacity should be utilized to reduce the construction cost. Roughness number should properly be changed according to the proposed canal section. (Fig 13.4)
● Freeboard	See Sub-section 13.6.7
● Conjunctive use	Design capacity of irrigation canal would not include drainage capacity. Water from surrounding fields might be drained by using of freeboard and capacity of existing canals.
● Inspection road	The main and secondary canals commanding over 1,000 m would have inspection roads of 4.0 m in total width. For canals of less than 1,000 m, total road width would be 2.0 m.
● Crossing structure	The minimum diameter of pipe culvert should be 0.6 m for maintenance.
● Measuring devices	Water level gauges should be installed at diversion structure to measure the discharge of diverted water. For tertiary canal, water would be distributed at full water level for certain period for rotational irrigation. Thus, water would not be controlled by discharge but by maintaining of the full water level with off-take gate.

Table 13.1 Target Level and Standard of Rehabilitation and Reconstruction of Irrigation and Drainage System (2/2)

Item	Target Level and Standard
Pond	
● Pond	Depth of pond should be 3.0 m to utilize groundwater
● Related facilities	Wooden step (ladder), fence around the pond
Drainage	
● Improvement policy	Full improvement with unit drainage requirement, if capacity of rivers, streams and existing drains is sufficient and does not require major construction works. If not, drainage whose capacity is equivalent to the irrigation water to the area would be secured to maintain the original drainage condition in the area.
● Design capacity	Full Improvement: Consecutive 3-day rainfall of 1 in 10 year recurrence period should be drained within 3 days allowing inundation of 150 mm. Storage capacity of paddy field could be accounted (1.6 lit/s/ha for Takeo). Irrigation Scheme: Drainage whose capacity is equivalent to irrigation water to the area should be secured (about 1.0 lit/s/ha)
Responsibility	
● Construction	Up to secondary canal → MOWRAM (DWRAM) Tertiary and water courses → FWUC getting technical guidance and engineering services of MOWRAM (DWRAM)
● O&M	Medium to large irrigation scheme → MOWRAM (DWRAM) would support for certain period after completion (ex. 4 years). Within that period, intensive training would be conducted by MOWRAM (DWRAM) to FWUC. Small irrigation scheme would be handed over to FWUC after construction. MOWRAM (DWRAM) would provide technical support as required.

Table 13.2 Sample of Calculation of Irrigation Water Requirement

						June		July		August		September		October		November		December	
						1	2	1	2	1	2	1	2	1	2	1	2	1	2
	Basic cropping pattern																		
Year	**1985**																		
	ETo	a	(mm)			83.3	83.3	73.8	78.7	77.0	82.1	69.8	69.8	64.2	68.5	72.8	72.8	75.6	80.6
	Medium Paddy		**1,000**	**ha**															
	Nursery																		
1	Land preparation	b	(mm)					120.0	120.0	120.0	120.0	120.0							
	a. Area factor to total crop area	c						0.05	0.05	0.05	0.05	0.05							
	Area factor in period of nursery	d						0.20	0.20	0.20	0.20	0.20							
	Requirement for l.preparation	e = b * c * d	(mm)					1.2	1.2	1.2	1.2	1.2							
	Comsumptive use in nursery																		
	d. Crop factor	f						1.0	1.0	1.0	1.0	1.0							
	e. Comsumptive use of water	g = f * a	(mm)					73.8	78.7	77.0	82.1	69.8							
	Percoration	h	(mm)					2.0	2.0	2.0	2.0	2.0							
	CU+P	I = g + h	(mm)					75.8	80.7	79.0	84.1	71.8							
	Area factor to total crop area	j						0.05	0.05	0.05	0.05	0.05							
	Area factor in period of nursery	k						0.20	0.20	0.20	0.20	0.20							
	Comsumptive use in nursery	l = I * j * k	(mm)					0.8	0.8	0.8	0.8	0.7							
2	Main field of paddy																		
	Land preparation	m	(mm)						120.0	120.0	120.0	120.0	120.0						
	Area factor to total crop area	n							1.00	1.00	1.00	1.00	1.00						
	Area factor in period of nursery	o							0.20	0.20	0.20	0.20	0.20						
	Requirement for l.preparation	p = m * n * o	(mm)						24.0	24.0	24.0	24.0	24.0						
	After land preparation																		
	Crop factor	q																	
									1.10	1.10	1.10	1.05	1.05	1.05	0.95				
										1.10	1.10	1.10	1.05	1.05	1.05	0.95			
											1.10	1.10	1.10	1.05	1.05	1.05	0.95		
												1.10	1.10	1.10	1.05	1.05	1.05	0.95	
													1.10	1.10	1.10	1.05	1.05	1.05	0.95
	Comsumptive use of water	r = q * a	(mm)						86.59	84.65	90.29	73.24	73.24	67.41	65.06				
										84.65	90.29	76.73	73.24	67.41	71.90	69.11			
											90.29	76.73	76.73	67.41	71.90	76.39	69.11		
												76.73	76.73	70.62	71.90	76.39	76.39	71.82	
													76.73	70.62	75.33	76.39	76.39	79.38	76.61
	Percoration+submergence	s	(mm)						0.00	0.00	0.00	0.00	45.00	45.00	0.00				
										0.00	0.00	0.00	0.00	45.00	45.00	0.00			
											0.00	0.00	0.00	0.00	45.00	45.00	0.00		
												0.00	0.00	0.00	0.00	45.00	45.00	0.00	
													0.00	0.00	0.00	0.00	45.00	45.00	0.00
	CU+P	t = r + s	(mm)						86.6	84.6	90.3	73.2	118.2	112.4	65.1				
										84.6	90.3	76.7	73.2	112.4	116.9	69.1			
											90.3	76.7	76.7	67.4	116.9	121.4	69.1		
												76.7	76.7	70.6	71.9	121.4	121.4	71.8	
													76.7	70.6	75.3	76.4	121.4	124.4	76.6
	Effective rainfall(ER)	u	(mm)			12.0	12.0	22.7	22.7	13.1	13.1	71.4	71.4	95.3	95.3	63.8	63.8	0.0	0.0
	CU+P-ER																		
		v = t - u	(mm)						63.9	71.5	77.2	1.9	46.9	17.2	0.0				
										71.5	77.2	5.4	1.9	17.2	21.7	5.3			
											77.2	5.4	5.4	0.0	21.7	57.6	5.3		
												5.4	5.4	0.0	0.0	57.6	57.6	71.8	
													5.4	0.0	0.0	12.6	57.6	124.4	76.6
	Average of CU+P-ER	w	(mm)						63.9	71.5	77.2	4.5	13.0	6.9	8.7	33.3	40.1	98.1	76.6
	Area factor to total paddy crop area	x							0.20	0.40	0.60	0.80	1.00	1.00	1.00	0.80	0.60	0.40	0.20
	Crop water requirement	y = w * x	(mm)						12.8	28.6	46.3	3.6	13.0	6.9	8.7	26.6	24.1	39.2	15.3
3	Net irrigation water requirement	z = e + l + p +	(mm)					2.0	38.8	54.6	72.3	29.5	37.0	6.9	8.7	26.6	24.1	39.2	15.3
	Irrigation efficiency	aa						0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
4	Irrigation water requirement	ab = z / aa	(mm)					3.3	64.7	91.0	120.6	49.2	61.6	11.4	14.4	44.3	40.1	65.4	25.5
			(MCM)					0.03	0.65	0.91	1.21	0.49	0.62	0.11	0.14	0.44	0.40	0.65	0.26

Medium Paddy

Area required for nursery bed is assumed to be 5% of main fields.

In each of half a month, 20 % of nursery will be prepared.

In each of half a month, 20 % of main paddy fields will be prepared for transplanting.

Water requirements in main fields are calculated in each of fives blocks divided by five half a

Area planted / totoal area

Table 13.3 Sample Water Balance Calculation

Kpob Trobek Reservoir

Effective storage capacity:		2.63	MCM
Gross storage capacity:		2.77	MCM
Dead Storage:		0.13	MCM
Evaporation coeffcient from reservoir water surface		0.9	
Percolation loss from reservoir		0.5	mm/day
Irrigation area:	Medium paddy	2400	ha
	Short Paddy	1100	ha
	Upland crop 1	500	ha
	Upland crop 2	550	ha

Tumnup Lok reservoir

1.00	MCM	
1.66	MCM	
0.66	MCM	
0.9		
0.5	mm/day	

Year	Month	Inflow from Tumnup Lok	Inflow	Water demands	Average water surface area	Evapo. from reservoir	Percola-tion from reservoir	Water demands + Losses	Spillout	Net Storage Vol.	Deficit	Inflow	Average water surface area	Evapora-tion from reservoir	Percola-tion from reservoir	Loss from pond	Spillout	Net Storage Vol.
		(MCM)	(MCM)	(MCM)	(Mm3)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)		(MCM)	(Mm3)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)
	12									2.63								1.00
1966	1	0.44	0.06	0.50	1.905	0.134	0.014	0.65	0.00	2.48		0.30	1.413	0.099	0.011	0.11	0.00	0.75
		0.70	0.06	0.61	1.866	0.140	0.014	0.77	0.00	2.48		0.32	1.347	0.101	0.010	0.11	0.00	0.26
	2	0.33	0.03	0.60	1.757	0.147	0.013	0.76	0.00	2.08		0.16	1.011	0.085	0.008	0.09	0.00	0.00
		0.08	0.03	0.39	1.511	0.110	0.011	0.51	0.00	1.67		0.14	0.792	0.057	0.006	0.06	0.00	0.00
	3	0.03	0.02	0.33	1.257	0.118	0.009	0.46	0.00	1.26		0.11	0.779	0.073	0.006	0.08	0.00	0.00
		0.03	0.02	0.14	1.052	0.106	0.008	0.25	0.00	1.06		0.12	0.783	0.079	0.006	0.08	0.00	0.00
		0.00	4.05	2.34	1.890	0.119	0.014	2.47	1.52	2.63		11.99	1.413	0.089	0.011	0.10	11.89	1.00
	10	0.00	1.43	1.33	1.905	0.110	0.014	1.46	0.00	2.60		4.79	1.413	0.082	0.011	0.09	4.70	1.00
		1.96	1.03	2.96	1.898	0.117	0.014	3.09	0.00	2.50		5.11	1.413	0.087	0.011	0.10	3.06	1.00
	11	2.29	0.23	4.85	1.045	0.068	0.008	4.93	0.00	0.09		1.39	1.413	0.093	0.011	0.10	0.00	0.00
		1.31	0.23	3.22	0.153	0.010	0.001	3.23	0.00	0.00	Short	1.39	1.072	0.070	0.008	0.08	0.00	0.00
	12	0.31	0.04	1.42	0.111	0.000	0.001	1.42	0.00	0.00	Short	0.38	0.885	0.060	0.007	0.07	0.00	0.00
		0.33	0.04	0.97	0.111	0.000	0.001	0.97	0.00	0.00	Short	0.41	0.895	0.065	0.007	0.07	0.00	0.00
1995	1	0.08	0.00	0.50	0.110	0.000	0.001	0.50	0.00	0.00	Short	0.14	0.793	0.056	0.006	0.06	0.00	0.00
		0.09	0.00	0.41	0.110	0.000	0.001	0.41	0.00	0.00	Short	0.15	0.797	0.060	0.006	0.07	0.00	0.00
	2	0.03	0.00	0.70	0.110	0.000	0.001	0.70	0.00	0.00	Short	0.10	0.773	0.065	0.006	0.07	0.00	0.00
		0.02	0.00	0.46	0.109	0.000	0.001	0.46	0.00	0.00	Short	0.08	0.768	0.056	0.006	0.06	0.00	0.00
	3	0.00	0.00	0.39	0.109	0.000	0.001	0.39	0.00	0.00	Short	0.03	0.743	0.070	0.006	0.08	0.00	0.00
		0.00	0.00	0.09	0.109	0.000	0.001	0.09	0.00	0.00	Short	0.03	0.708	0.000	0.005	0.01	0.00	0.00
	4	0.00	0.00	0.00	0.108	0.000	0.001	0.00	0.00	0.00		0.02	0.706	0.000	0.005	0.01	0.00	0.00
		0.00	0.00	0.00	0.108	0.000	0.001	0.00	0.00	0.00		0.02	0.703	0.000	0.005	0.01	0.00	0.00
	5	0.00	0.00	0.00	0.107	0.000	0.001	0.00	0.00	0.00		0.02	0.701	0.000	0.005	0.01	0.00	0.00
		0.00	0.00	0.04	0.107	0.000	0.001	0.04	0.00	0.00	Short	0.02	0.698	0.000	0.005	0.01	0.00	0.00
	6	0.00	0.00	0.00	0.107	0.000	0.001	0.00	0.00	0.00		0.02	0.696	0.000	0.005	0.01	0.00	0.00
		0.00	0.00	0.02	0.106	0.000	0.001	0.02	0.00	0.00	Short	0.02	0.693	0.000	0.005	0.01	0.00	0.00

Table 16.1 Maintenance of Irrigation Facilities

Facilities	Maintenance Level	Maintenance Item	Main Responsibility [1)]
Reservoirs	Routine	● Inspection of gate condition ● Inspection of dike condition ● Inspection of seepage/leakage condition	SO, reservoir in charge, FWUC APEX
	Annual	● Painting of gates ● Removing of debris ● Minor repair of dike and gates	FWUC APEX Labor contribution by FWUC members
	Periodical (every 5 years)	● Removal of sediment to intake gates ● Repair of dikes by construction machines ● Replacement of wooden stop-logs	FWUC APEX Peace work by members
Diversion Canal	Routine	● Inspection of gate condition ● Inspection of canal condition	SO for reservoir, FWUC APEX
	Annual	● Checking and removal of sediment in siphon ● Removal of debris in the canal ● Minor repair of the canal ● Painting of screen of the siphon	FWUC APEX Labor contribution by FWUC members
	Periodical (every 5 years)	● Repair of the canal by construction machine ● Repair of inspection road and structures ● Replacement of wooden stop-logs	Piece work by members FWUC APEX
Main Canal	Routine	● Inspection of gate/structure condition ● Inspection of canal condition ● Inspection of structure condition	SO in charge of main canal, APEX SC FWUC
	Annual	● Removal of debris in the canal ● Minor repair of the canal ● Painting of screen of the siphon	FWUC APEX Labor contribution by members
	Periodical (every 5 years)	● Repair of the canal by construction machine ● Repair of structures ● Replacement of wooden stop-logs	FWUC APEX Piece work by members
Secondary Canal	Routine	● Inspection of gate/structure condition ● Inspection of canal condition ● Inspection of structure condition	SO of each SC-FWUC
	Annual	● Removal of debris in the canal ● Minor repair of the canal ● Painting of screen of the siphon	SC-FWUC Labor contribution by members
	Periodical (every 5 years)	● Major repair of canals ● Repair of structures ● Replacement of wooden stop-logs	SC-FWUC Piece work by members
Tertiary Canal	Routine	● Inspection of gate/structure condition ● Inspection of canal condition ● Inspection of structure condition	FO
	Annual	● Removal of debris in the canal ● Minor repair of the canal ● Painting of screen of the siphon	FO Labor contribution by members
	Periodical (every 5 years)	● Major repair of canals ● Repair of structures ● Replacement of wooden stop-logs	FO Labor contribution by members

Note: 1) Please refer to Fig. 16.2 “Responsibility of FWUC/FWUG by Scheme ~ I. Large/Medium Scale Irrigation Scheme”.

Table 17.1 Sample of Project Description and Screening (1/2)

1. Brief Description of Project

Outline of Project Area:	Existing cultivated land extending mainly on the right bank of the Slakou River in Takeo Province
Beneficiaries and Benefited Area:	65,000 ha as total Study Area, 3,500 ha covered by USP (39 villages)
Relevant Main Components:	SRP (280 ha), PDP (2,100 ha), RIP (154 km), Agriculture Support Program, Institutional Development Program
Executing and Related Agencies:	Ministry of Water Resources and Meteorology (Ministry of Rural Development and Ministry of Agriculture, Forestry and Fishery as related agencies)
Environmental Agencies Concerned:	Ministry of Environment

2. Major Components of Project and Screening for Initial Evaluation

Major Components	Type		Scale and Characteristic		Screening
	New	Rehab	Area, etc.	Characteristic	
a. Irrigation					
a-1 USP		○	Total: 3,500 ha	Rehabilitation of Tumnup Lok and Kpob Trobek reservoirs, rehabilitation of main and secondary canals (total 66 km)	
a-2 SRP		○	Total: 280 ha	Rehabilitation of 14 small reservoirs	
a-3 PDP	○	○	Total: 2,100 ha	Development or improvement of 18,000 small ponds	
b. Drainage		○		Improvement of drainage condition as a scheme of USP	screen out
c. Land clearing & leveling					N.A.
d. Sea/swamp reclamation					N.A.
e. Land consolidation					N.A.
f. New land settlement					N.A.
g. Dam & reservoir					
g-1 USP		○		Tumnup Lok: 1.0 mill. m^3 Kpob Trobek: 2.5 mill. m^3	
g-2 SRP		○		Total 963 thou. m^3	
g-3 PDP	○	○		Total 5.3 mill. m^3	
h. Change in farming system		○		Improvement of secondary cropping	screen out

Table 17.1 Sample of Project Description and Screening (2/2)

Major Components	Type		Scale and Characteristic		Screening
	New	Rehab	Area, etc.	Characteristic	
i. Others					
i-1 RIP	○	○	154 km	Laterite surfacing road of 5 or 6 m wide	
i-2 Fertilizer use	○	○	USP, SRP, PDP	Paddy: 3.3 times Secondary crop: 2.5 ~ 6 times	
i-3 Livestock husbandry	○	○	USP, SRP	Increment of potential productivity	
i-4 Farmers group	○	○	USP, SRP, PDP	Acting body for agriculture support	screen out
i-4 Agricultural Extension			- ditto -	Extension service on farmers group basis	screen out
i-5 Credit			- ditto -	Credit service on farmers group basis	screen out
i-6 Agro-processing & marketing	○		Part of USP area	Development of system for collection and shipping of agricultural product	screen out
i-7 FWUC	○		USP area	Acting body for O&M of irrigation system	screen out
i-8 Capacity building		○		Capacity building of DWRAM, Takeo	screen out

Remarks:

USP: Upper Slakou Irrigation Reconstruction Plan
SRP: Small Reservoir Rehabilitation Plan
PDP: Small Pond Development Plan
RIP: Rural Road Improvement Program

Note:

1. N.A. means “Not Applicable”.
2. Components screened out in the above table will cause no negative impacts obviously, and not be designated as the components to be examined in initial evaluation.

Table 17.2 Summarized Site Description (1/2)

1. Present Socioeconomic Status of the Project Area

Land ownership and land use, etc.	Although government granted land-use right, most of the land-use ownership in the Project Area has not been legally registered yet. Farming in ruined reservoirs and canals, even illegal, can be observed in the Project Area.
Economic activities	Most of households in and around the Project Area are engaged in agriculture. Very few economic activities of other industrial sectors are observed.
Customs (water right, etc.)	In the Project Area and its lowland, water of rivers, ponds, and reservoirs is mainly used for agricultural or fishery activities. However, none of customs or systems on water use right exists, and fishery rights are limited along the Bassac river.
Host people or community	Widow-headed households of 20 % or more are recognized as vulnerable groups in the Project Area. There are no minority or indigenous groups in the Project Area.
Health and sanitation	Malaria, as water-borne diseases, is commonly seen especially near the mountain area at the upstream of the Project Area. Sanitary conditions including drinking water are considerably poor.
Population	Total population and households in the Project Area are about 165,600 persons and 33,000 households. Percentage of male/female is 89.1 %.
Others	(mentioned in "4. Other Information)

2. Natural Conditions of the Project Area

Climate	Annual mean temperature is 28.0℃ (Pochentong station, '91-'00). Rainfall on an annual average is about 1,200 mm in the lowland of the Project Area, and 90 % of it occurs during the wet season (May-Nov.).
Topography	The topography of the Project Area is gentle on a whole. The elevation ranges from EL 60 m to EL 6m with a slope of 1/100 to 1/1,000.
Hydrology and drainage	The Slakou river finally flows into the Bassac river through Thnot Te reservoir. Catchment area at Route No. 3 of the Slakou River is 1,200 km^2, and catchment area of three ruined reservoirs sums up to 520 km^2. Runoff of the Slakou river basin is very small in the late dry season.
Soil	The lessive soils are dominantly occupying 54,000 ha (83 %) of the Project Area. Fertility and productivity are low to medium.
Forest and vegetation	Most of the Project Area is covered by paddy field and secondary crop land, and forest is very limited. Scrub and abandoned field covered by scrub spread at the foot of Noreay mountain, and are observed occasionally around the O Saray reservoir.
Rare species or fragile ecology	It seems that none of rare or endangered species exists in the Project Area.
Water quality	The analytical results of water quality in dry season indicate that the both surface and ground water are highly polluted with fecal contamination from the view point of drinking water resources. For irrigation use, there are no serious problems on the water quality.
Others	(mentioned in "4. Other Information")

Table 17.2 Summarized Site Description (2/2)

3. Area under Specific Designation

Items	Applicable or Not			
	in the P.A.		Vicinity of the P.A.	
	Appl.	N.A.	Appl.	N.A.
Habitat of fauna and flora in CITES		○		○
Wetland designated in Ramsar Convention		○		○
Heritage sites under the World Heritage Convention		○		○
Protected areas (National park, wildlife sanctuaries, etc.)		○		○
Others				
Forest concession area		○	○	
Reforestation project area	○		○	

Remark
P.A.: Project Area
CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora

4. Other Information

1) Socioeconomically sensitive issues
- Most of households in Takeo Province use firewood and charcoal for energy of daily life.
- Small swamps, ponds, and streams in the Project Area are utilized for family fishing. Fish is important resource for not only the domestic diet but income generation for local people.
- The majority of households in the Project Area mainly fetch water for drinking or other use from nearby streams and ponds in dry season.

2) Naturally sensitive issues
- Forest areas in and around the Project Area are threatened with extraction and deforestation, because of illegal logging.
- There are two (2) reforestation projects in and around the Project Area, which are directly or indirectly managed by Department of Forestry and Wildlife of MAFF.
- The geological layer in and around the Project Area is alluvium consisting of sand, silty sand, and sandy silt, which are relatively erodible.
- The nearest protected areas around the Project Area are Kirirom National Park and Phnom Bokor National Park. Since they are located at a distance of about 40 km from the boundary of the Project Area respectively, no environmental impacts are expected.
- There are no tropical forest and wetland in and around the Project Area.

Table 17.3 Initial Evaluation (Social Issues) (1/2)

Environmental Element / Major Comp. [1/]	Evaluation of the Main Components of Project [2/]								
	a-1	a-2	a-3	g-1	g-2	g-3	i-1	i-2	i-3
1. Socioeconomic Issues									
1) Social Issues									
Planned agricultural settlement	*	*	*	*	*	*	*	*	*
Compulsory relocation of houses	-/C	-/C	*	-/C	X	*	-/C	*	*
Land expropriation	-/C	-/C	*	-/C	X	*	-/C	*	*
Changes in mode of living	X	X	X	X	X	X	+/C	*	X
Conflict among villagers	X	X	X	X	X	X	X	*	*
Immigrants, refugees and nomads	*	*	*	*	*	*	*	*	*
2) Demographic Issues									
Population increase	*	*	*	*	*	*	*	*	*
Change of population composition	*	*	*	*	*	*	*	*	*
3) Economic Activities									
Change of economic activities	X	X	X	X	X	X	X	*	+/C
Change of occupation and labor opportunity	+/C	+/C	X	+/C	+/C	X	+/C	*	X
Income disparities	X	X	X	X	X	X	*	+/C	+/C
4) Institutional and Custom Related Issues									
Water/fishing rights	*	*	*	*	*	*	*	*	*
Change of social or institutional structures	X	X	X	X	X	X	*	*	*
2. Health and Sanitary Issues									
Use of agricultural chemicals	*	*	*	*	*	*	*	*	*
Residual toxicity of agricultural chemicals	*	*	*	*	*	*	*	*	*
Water-borne diseases	-/C	-/C	-/C	-/C	-/C	-/C	*	*	*
Domestic and other wastes	X	X	X	X	X	X	*	*	-/C
3. Cultural Property Issues									
Historic and cultural assets	X	X	X	X	X	X	X	*	*
Aesthetic sites and landscape	X	X	X	X	X	X	X	*	*

1/: Major components to be examined (See Table 17.1)

2/: Each applicable item is marked with the following classifications.

+/A: Upper part shows the direction of impacts and lower part shows the magnitude of impacts.
A: Relatively high magnitude of impacts is anticipated.
B: Relatively medium magnitude of impacts is anticipated.
C: Relatively low magnitude of impacts is anticipated.
X: No effect is expected.
*: No relation
+: Positive effect is expected.
-: Negative effect is anticipated.

Table 17.3 Initial Evaluation (Natural Issues) (2/2)

Environmental Element	Evaluation of the Main Components of Project [2/]								
Major Comp. [1/]	a-1	a-2	a-3	g-1	g-2	g-3	i-1	i-2	i-3
4. Biological and Ecological Issues									
Change in vegetation	X	X	X	X	X	X	X	*	X
Impacts on important or indigenous species	X	X	X	X	X	X	X	X	X
Degradation of precious ecosystem	X	X	X	X	X	X	X	*	X
Encroachment on wetlands	*	*	*	*	*	*	*	*	*
Degradation of forest resource	X	X	X	-/B	-/C	X	-/B	*	X
Degradation of mangrove forest	*	*	*	*	*	*	*	*	*
Degradation of coral reef	*	*	*	*	*	*	*	*	*
Depreciation of fisheries	-/C	-/C	X	+/C	+/C	+/C	X	-/C	X
5. Soil and Land Issues									
Soil erosion and sedimentation	-/C	-/C	X	-/C	-/C	X	-/C	*	*
Soil salinization	X	X	X	*	*	*	*	*	*
Loss of soil fertility	X	X	X	X	X	X	X	+/B	+/C
Soil contamination	*	*	*	*	*	*	*	*	*
Land devastation or desertification	*	*	*	*	*	*	*	*	*
Devastation of hinterland	X	X	X	-/B	-/C	X	-/B	*	*
Ground subsidence	*	*	*	*	*	*	*	*	*
6. Hydrology, Water Quality, etc.									
Change in surface water hydrology	X	X	X	-/C	X	X	*	*	*
Change in groundwater hydrology	X	X	X	X	X	X	*	*	*
Inundation and flood	X	X	*	X	X	*	*	*	*
Riverbed degradation	X	X	*	X	X	*	*	*	*
Impediment of inland navigation	*	*	*	*	*	*	*	*	*
Contamination of water quality	-/C	-/C	X	*	*	*	*	-/B	-/C
Eutrophication	*	*	*	-/C	X	X	*	X	X
Low temperature water	*	*	*	X	X	X	*	*	*
Atmosphere pollution	*	*	*	*	*	*	-/C	*	*

1/: Major components to be examined (See Table 17.1)

2/: Each applicable item is marked with the following classifications.

+/A: Upper part shows the direction of impacts and lower part shows the magnitude of impacts.
A: Relatively high magnitude of impacts is anticipated.
B: Relatively medium magnitude of impacts is anticipated.
C: Relatively low magnitude of impacts is anticipated.
X: No effect is expected.
*: No relation
+: Positive effect is expected.
-: Negative effect is anticipated.

Table 17.4 Approaches and Samples of Mitigation Measures (1/2)

1. Social Issues

Potential Negative Impacts	Approaches / Samples of Mitigation Measures
Resettlement and Land acquisition.	- Adequate selection and provision of new settlement area with housing and infrastructure based on wishes of affected people. - Economic compensation and establishment of supporting system for restoration of living conditions. - Provision of employment opportunities during the construction or operation stages of project.
Conflicts over water supply and inequalities in water distribution.	- Means to ensure equitable distribution among users and monitor to assure adherence. - Limitation of withdrawal so that it does not exceed safe yield (recharge rate).
Conflicts caused by population increase or change in population composition.	- Improvement or establishment of infrastructure. - Formulation of settlement plan with due consultation to both host and migrated people. - Introduction of staged development.
Water quality deteriorated or made unusable by upstream land use and pollutants discharge.	- Control of land use in watershed areas. - Control of pollution sources. - Water treatment prior to use.
Introduction or increase in incidence of waterborne or water-related disease. (malaria, etc.).	- Use of lined canals or pipes to discourage vectors. - Avoidance of stagnant or slowly moving water. - Use of straight or slightly curving canals. - Installation of gates at canal ends to allow complete flushing. - Filling or draining of borrow pits. - Disease prophylaxis and treatment.
Diseases and health problems from use of wastewater in irrigation.	- Reduction of pollutants discharge from irrigation service area. - Improvement of agricultural practices and control of input (especially agro-chemicals, fertilizers, livestock husbandry, etc.). - Wastewater treatment (e.g. settling ponds) prior to use. - Establishment and enforcement of standards for wastewater use.
Impediment to movement or inland navigation.	- Provision of passageways or water-ways.
Threat to historic, cultural, or aesthetic features.	- Siting of project to prevent loss. - Salvage, relocation, restoration, or protection of cultural property.

Table 17.4 Approaches and Samples of Mitigation Measures (2/2)

2. Natural Issues

Potential Negative Impacts	Approaches / Samples of Mitigation Measures
Soil erosion.	- Proper design and layout of slopes and field avoiding too steep a gradient. - Slope protection and land leveling. - Design of terraces on hillsides minimizing surface erosion. - Formulation of physical and agronomical conservation.
Salinization of soils.	- Drainage improvement for avoidance of waterlogging. - Leaching of salts periodically. - Improvement of farming / cropping practice. - Application of crops with salinity tolerance.
Clogging of canals / reservoirs by sediments / weeds.	- Minimization of erosion of fields and upper watershed. - Introduction of land use regulation and land conservation measures such as afforestation. - Design and management of canals / reservoirs for removal of sediment / weeds. - Provision of access to canals / reservoirs for removal of sediment / weeds.
Deterioration of soil fertility.	- Reduction of soil erosion from fields. - Avoidance of over watering against leaching nutrients. - Replacement of nutrients by fertilizers or crop rotation.
Water blooms and algae proliferation.	- Reduction of input of nutrients (nitrogen and phosphorous) to fields. - Reduction of release of nutrients from fields.
Contamination of water quality in downstream.	- Improvement of water management. - Improvement of agricultural practices and control of input (especially agro-chemicals, fertilizers, livestock husbandry, etc.). - Regulation of waste disposal. - Imposition of water quality criteria.
Reduction of downstream flow.	- Regulation of intake to minimize impacts. - Proper operation of reservoirs and canals. - Redesign of project. - Application of compensatory measures where possible.
Encroachment on ecologically sensitive areas such as swamps, natural forests, etc.	- Establishment of buffer zones and protected areas. - Establishment of compensatory areas. - Siting of project to avoid or minimize loss on critical areas.
Alteration or destruction of wildlife habitat, impediment to movement of wildlife.	- Establishment of buffer zones and protected areas. - Establishment of compensatory areas. - Siting of project to avoid or minimize loss on critical areas. - Animal rescue and relocation. - Provision of corridors for movement.