

**PART 2 FEASIBILITY STUDY FOR THE
PRIORITY PROJECT AREAS**

**I. COLMATAGE FARMING IMPROVEMENT PROJECT
IN THE PRIORITY AREA**

CHAPTER 1 PRESENT CONDITIONS

1.1 Study Area

1.1.1 Right Bank of Mekong River

The Study Area is located at Kean Svay district along National Road No.1. It is about 50 km south-east from the Phnom Penh. The Study Area is about 2,640 ha.

1.1.2 Left Bank of Bassac River

The Study Area is located at Saang district along the natural levee of Bassac river, that is 35 km south from the Phnom Penh. The Study Area is about 720 ha.

1.1.3 Right Bank of Bassac River

The Study Area is located at Saang district along the right natural levee of Bassac river. It is located 30 km south of Phnom Penh and covers about 1,500 ha. The total area of the three (3) Study Areas are about 4,900 ha (see Figure 1.1).

1.2 Colmatage Canals

1.2.1 Right Bank Area of Mekong River

There are six (6) colmatage canals with a recession rice area of 890 ha, wet season rice area of 48 ha and upland crop area of 1,700 ha. The intake gates of the canals except for the Prek Chrey colmatage were constructed before 1975. The mean length and the bottom width of canals are estimated at 2.4 km and 10 m, respectively. Considering the farmer's interview, rehabilitation and reconstruction of the intake gates, dredging of canals, reshaping of slopes and repair of maintenance road along the canals are desirable for agricultural activities. Also, according to the Rural Socio-economic Survey, farmers are willing to participate in the maintenance works for dredging of canals and rehabilitation of roads. (The project for the rehabilitation of colmatage canals had been requested to the Japanese Government in 1994 by the MAFF.) At present, two (2) of the colmatage canals are not functional. One of this canal is the Prek Chrey located 4.05 km, next to the Samrong Thom. As for the Prek Chrey, existing gate and bridge/culvert of this canal were removed at the time of the rehabilitation of National Road No.1. The farmers express the desire to recover those intake gate and culvert. To recover the agricultural production activity in the original beneficial area, those facilities should be re-constructed. As for the Samrong Thom, the land of canal in the Mekong river side, in front of the intake gate, was bought and filled by a private company (S.L.Co.). Some areas behind the gate are also used by the S.L.Co. However, there are still farm lands located behind the gate. A canal connected to the Mekong river and the intake gate is needed for farming. Some actions for the solution of the problems shall be undertaken by MAFF and GD/MH (see Table 1.1).

The Cambodia Government has applied for a loan from the Asian Development Bank (ADB) to rehabilitate the Cambodian portion of the National Road No. 1 Highway Improvement Project

(57 km from Phnom Penh to Neak Loeng). The ADB assisted project (preliminary design) with the Ministry of Public Works and Transport (MPWT) as implementing agency was started in middle of 1996.

1.2.2 Left Bank Area of Bassac River

There are eight (8) colmatage canals in this area. The averages of bottom width, depth and length of the canals are 12.4 m, 2.0 m and 1.7 km, respectively. No intake gates exist in the canals. The slopes of the canals are eroded by flood water and rainfall. Almost all of the roads along the canals are bumpy and narrow. Dredging works of the canals are needed strongly. The average beneficial farm lands of each canal for recession rice, wet season rice and upland crop are 52 ha, 20 ha and 18 ha, respectively. The three (3) canals of Prek Thmei, Prek Ta Pe and Kranh are selected as high priority for rehabilitation because farming activities along the canals are more intensive (see Table 1.1). Also, the farmers express the intention to rehabilitate the canals. As for agricultural activities, together with the area along the colmatage canals, the areas behind the canals are found to be active by using impounded water with dikes and water control gates.

1.2.3 Right Bank Area of Bassac River

There are seven (7) colmatage canals in this area. The averages of bottom width, depth and length of the canals are 11.6 m, 2.9 m and 2.0 km, respectively. There are no intake gates in the canals. The conditions of the canals are bad for water flow as well as the others. In the wet season, the roads become muddy. Access to the roads becomes difficult even for carts and motorbikes. The average farm lands of each canal for recession rice, wet season rice and upland crops are 86 ha, 57 ha and 71 ha, respectively. The three (3) canals of Thei, Kseiv and Me Srok are considered to be the priority canal for rehabilitation according to the field survey (see Table 1.1).

1.3 Agriculture

1.3.1 Rural Socio-economic Survey

A survey was carried out by the JICA Study Team from May to July 1997 to understand rural conditions covering family and farm size, educational status, income and expenditure, land use and agricultural production, farmer's problems and needs, farm economy, etc. Some 100 farmers in the 10 villages were selected and interviewed at random.

The colmatage beneficial area was divided by three sub areas, namely Kean Svay, Saang (Bassac Left) and Saang (Bassac Right). The 100 farmers interviewed were selected based on the sub-area. In Kean Svay, where there are four (4) colmatage canals, 28 farmers consisting of 7-farmers' at each colmatage canal were interviewed. In the other two sub-areas, where there are three (3) colmatage canals, 36 farmers consisting of 12-farmers' at each colmatage canal were interviewed.

1.3.2 Farm Size

All the interviewed farmers have their farmland. The table below shows the average number of

farm plots and average farm size by sub-area.

Sub Area Name	No. of Plots	Average Farm Size ³⁾ (ha)		
		Paddy Field	Upland Field	Total
Kean Svay	2.4	1.08	0.86	1.73
Saang (Bassac Left)	3.2	0.51	0.32	0.81
Saang (Bassac Right)	2.4	0.39	0.30	0.66
Average	2.7	0.61	0.46	1.01
M/P Interview ¹⁾	-			1.12
M/P Interview ²⁾	-			1.06

(Source: JICA Study Team, 1997)

(Note: ¹⁾ Conducted in May 1996 for 33 farmers in Kean Svay District.)

(Note: ²⁾ Conducted in May 1996 for 32 farmers in Saang District.)

(Note: ³⁾ For calculation, farmers who have no paddy/upland field are omitted.)

1.3.3 Farming Practice

Of the farmers interviewed, 95 farmers cultivate either wet season or dry season paddy. However, about one third of these farmers replied that paddy production was not enough even for home consumption. Only 15 farmers sell their produce (paddy). This means that the farmer's agricultural income comes mainly from upland crop's sale. (The average agricultural income of the 100 farmers is about 2-million Riels/year/household.)

The maize is the most popular upland crop during wet season (59 farmers). Other crops planted are sugarcane (13 farmers), peanut and mungbean (both 8). During the dry season, mungbean is most popular among 15 crops (21 farmers). Peanut (19) and sugarcanes (14) are the other crops planted during the dry season.

About 90% of interviewees replied that they wanted information on farming technology and fertilizer/agricultural chemical's application method. Although, most of farmers interviewed (96) never receive extension services they usually learn the use fertilizer and agricultural chemicals from neighbors (89) and material shops (33).

Possession of animal and farm equipment in the area are as follows;

Item	No. of Own Farmer	Average
Draft Animal (heads)	74	2.5
Pig (heads)	48	2.3
Chicken (heads)	84	7.9
Duck (heads)	10	5.8
Hand Sprayer	36	1.0
Mobile Pump	43	1.0

(Source: JICA Study Team, 1997)

Information on the average farm labor per household is presented in the table below.

(Unit: persons)

Sub Area Name	Male Agricultural Labor		Female Agricultural Labor	
	Full-time	Part-time	Full-time	Part-time
Kean Svay	1.21	0.79	1.46	0.61
Saang (Bassac Left)	1.25	0.47	1.56	0.42
Saang (Bassac Right)	1.19	0.50	1.50	0.39
Average	1.22	0.57	1.51	0.39
M/P Interview ¹⁾	1.76		2.33	
M/P Interview ²⁾	1.56		2.03	

(Source: JICA Study Team, 1997)

(Note: ¹⁾ Conducted in May 1996 for 33 farmers in Kean Svay District.)

(Note: ²⁾ Conducted in May 1996 for 32 farmers in Saang District.)

1.3.4 Farmers Organization

There are no farmer's organization/association in the area. However, about 99 farmers are willing to join a water users' association if established. On the average, one farmer is willing to pay about 90,000 Riels/ha/year for water charge.

According to the survey, the farmers' problems are shortage of water and transportation of agricultural production. Farmers interviewed expressed their intention to participate in the dredging of canal and repair of the road along the canals as form of participation in the development of their area. About 21 (or 29%) of farmers against the total number of 72 in the Bassac area express the desire to use pumping station for dry season irrigation water.

For demands/needs, irrigation facility development is the top priority for the farmers' interviewed (7.5 points out of 9.0). The second priority is flood protection (6.0 points), and the third priority is farm road development (5.1 points).

1.4 Farm Economy

1.4.1 Family Size

The total population in the 10 villages covered by the colmatage beneficial area is 23,160. The number of families in the area is 4,343 with an average family size of 5.33 (refer to Table 1.2).

1.4.2 Farm Size and Land Holding

Land distribution in the Area was started in 1987. Each family was given 1,500m² for housing and backyard culturing for home consumption.

The Krom Samaki, a farmer's organization now abolished, discussed the distribution of farmland among members and considered the average farm size of 0.2 to 0.3 ha per family. Considering this, the district office issued the land certificate to the individual farmers.

There are three (3) categories for allocation of farmland. The width and length of the individual farm lot per family were decided considering availability of water from colmatage and fairness of distribution, as follows.

- a) farm lots along colmatage but far from villages
one farm lot=15~20m width x 150~200m length
- b) farm lots along colmatage nearby village areas
one farm lot=10~20m width x 80~100m length
- c) farm lots not along colmatage
one farm lot=0.5 to above 1.0 ha

However, the farmers have already sold their lands due to financial reason, absence of animal labor, etc.

The average farm size in the Study Area was estimated at 1.1 ha per farm households according to the result of the Rural Socio-economic Survey. This was used for the financial analysis of its typical farm household.

1.4.3 Incomes and Expenditure

Income sources of farm households in the Study Area are composed of farm income, fishery income, other off-farm incomes. Findings show that some members of the family have permanent or temporary jobs in and outside the districts to supplement family incomes.

The total annual income in the area is estimated to be about 1.2 million Riels per family. This is higher than that of the Ksach Kandal area. About 78% of the total income source are from farming. Farmers planting cash crops with higher cropping intensity under irrigated condition through the colmatage canal have higher incomes. However, the total income is still below the poverty line of 2.2 million Riels. It is also estimated that about 64% of expenditure are used for food.

1.4.4 Debt and Credit

Some 1,586 farm households in Kean Svay district are provided agricultural credit services through the GRET, French NGO, that correspond to about 50% of the total farm families in the district. Most of debts are for short-term credit under the condition of four (4)% interests per month and 5 to 10 month's repayment period. Amount of debt per household is equivalent to 47 US\$. Repayment at the end of period is reported to be 100%. Saang district is not covered by the GRET's activities.

CHAPTER 2 PROJECT FORMULATION

2.1 Agricultural Production Plan

The agricultural production in the priority area will increase with the rehabilitation of colmatage system. At present, the cropping ratio of upland crops during the dry season represents 16 % of the whole cropping area. Dry season cropping can be increased by controlling water level of colmatage canal with installation of control gates. The target is to increase the upland cropping ratio during the dry season from 16% to 23% of the whole cropping area (see Figure 1.2).

The proposed cropping pattern is shown in Figure 2.1 while the production data with/without the projects are also shown in Table 2.1. The present yields are obtained from statistical data. Considering the results of the Rural Socio-economic Survey, cropping season, major paddy varieties, cropping ratio and target yields are decided. In comparison with the Colmatage Farming Improvement Project in Kandal Province, the distribution of planted area by crop was modified according to the results of Rural Socio-economic Survey. Therefore, both vegetables and beans are increased but maize is decreased (see Table 2.1).

2.2 Colmatage Canal Rehabilitation Plan

2.2.1 Canal Rehabilitation Plan

The colmatage canals are divided into five (5) types for planning purposes. The rehabilitation plan is applied for each canal according to the type. Taking account of the size and the capacity of the present canals, the numbers of applied canals are planned as four (4) for type-A, none for type-B, six (6) for type-C, eight (8) for type-D and three (3) for type-E. Prek Chrey was excluded in the planning since it has not been used after the removal of the facilities. The number of projected canal is 20, the capacity of which is relatively larger as compared with those of the others. The total canal length to be rehabilitated is planned at about 36 km.

Installation of gate is planned in the five (5) canals based on the present condition. In the Colmatage Farming Rehabilitation Project in Kandal Province, 17 canals are planned to install gate. The establishment of operation and maintenance organization and the provision of operation capability are prerequisite to installation of them. Provision with/without gates should be decided based on the farmer's capability to operate and maintain facilities and status of water user's association. The intention and ability of the farmers should be affirmed by the GDMH. Under such consideration, no new installation is planned in this study. In the project implementation stage, the canal equipped with gate may be added. In the designing facilities, pile foundation is planned due to soft soils.

Rehabilitation of bridge is planned at 10 canals. Road width is planned at 4.0 m (effective width of 3.0 m). Slope of canal is set 1:1.5. Rehabilitation of bridge in the National Road No.1 was not included in this plan, since ADB's project was undergoing.

2.2.2 Project Cost Estimation

The project cost consists of construction, project administration, consulting services and physical

contingency (basic condition for cost estimation is referred to in 3.2.1, II, Part 2). Considering the conditions, the project cost of the three (3) Study Area was estimated as follows.

Project Cost				Unit: 1,000 US\$
Area	Canal	Gate	Bridge	Total
Right Bank of Mekong	1,234	2,717	-	3,951
Left Bank of Bassac	1,022	-	228	1,250
Right Bank of Bassac	1,180	-	182	1,362
Total	3,436	2,717	410	6,563

The details are shown in Table 2.2.

2.2.3 Project Implementation Program

The GDIMH will be the lead implementing agency. The project implementation schedule is planned three (3) years after completion of this study. In the implementation stage, construction and rehabilitation works of the canals would be conducted throughout the year except during the heavy flooding season from August to September. Detailed survey and soil investigation should be conducted in the detailed design stage. Since some parts of the inside canal land are occupied by private agricultural owners and others, necessary measures for land preparation should be undertaken by GDIMH as the responsible agency.

CHAPTER 3 PROJECT JUSTIFICATION

3.1 Economic Evaluation

3.1.1 Method of Evaluation

The rehabilitation works for the existing colmatage canals in the priority area will be justified from the national economic point of views by using indicator of economic internal rate of return (EIRR). If EIRR calculated is higher than 10%, which is opportunity cost of capital of Cambodia, implementation of the project will be considered as economically feasible. Prices used in the economic evaluation are converted from financial to economic. Prices of tradable commodities such as paddy and fertilizer were estimated based on prices forecasted by the World Bank. Also, current market prices are used for non-tradable commodities. Project financial cost is converted into economic project cost by using conversion factors that are calculated from statistics on import and export value over five (5) years. Financial prices used in the evaluation were collected from May to July in 1997 during the feasibility study stage.

3.1.2 Agricultural Benefits

Direct benefit to be generated by the implementation of rehabilitation works for the colmatage canals are: a) increase in crop yield, b) increase in cropping intensity, c) increase in planting areas for the proposed crops such as paddy, maize, vegetables, in wet season and paddy, maize, beans, vegetables as dry season crops, and banana for perennial crops. Incremental agricultural benefit was estimated as shown in Table 3.1.

The project cost in financial basis was estimated at 6.56 million US\$, which corresponds to 5.75 million US\$ in economic cost (refer to Table 3.2). In the estimation of economic cost, taxes, price escalation, compensation and subsidy were not taken into account because of transference costs. Replacement costs for gates were accounted every 30 years.

3.1.3 Project Justification

Economic project cost and benefits were discounted using definite discount rates for 50 year's project life to calculate present values. The estimated economic internal rate of return (EIRR) of the project was 13.9%. Considering the 10% opportunity cost of capital in Cambodia, the project is considered to be economically viable from the national economic point of view because the EIRR estimated is higher than 10%.

3.2 Financial Analysis

Financial analysis was carried out based on the typical farm size of 1.1 ha, planting dry season paddy plus maize plus vegetables. In this study, farm economies between the two (2) cases of with and without project, were compared. The result of the study shows that farm household incomes will be raised and disposable income will also be expected (see Table 3.3).

CHAPTER 4 CONCLUSIONS AND RECOMMENDATIONS

The Colmatage Farming Improvement Project was formulated considering the advantages of traditional farming practice with the annual hydrological and ecological cycle of the Mekong. The project will produce many agricultural benefits and environmental conservation effect. The proposed project in the priority area is recognized as a pilot project. The outcomes of the priority area will be extended into the next colmatage area in Kandal province. The project is considered as feasible due to high economic viability from the quantitative sense. The project is recommended to be implemented urgently.

For smooth and successful implementation of the project, it is necessary to reorganize beneficial farmers into the operation and maintenance organization by canal. Related to the project implementation of the right bank of the Mekong river, it is required to coordinate with the National Road No.1 Improvement Project.

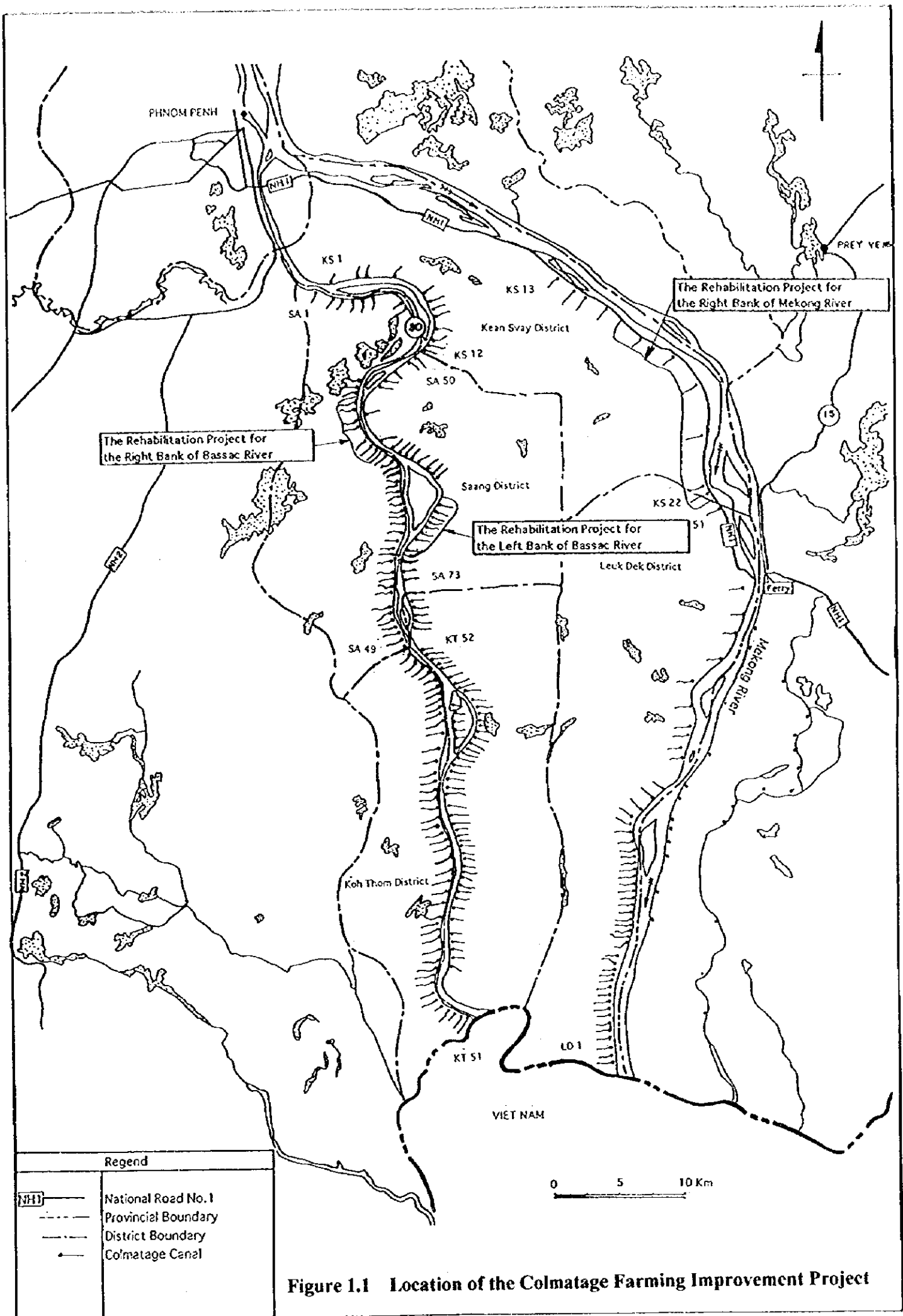
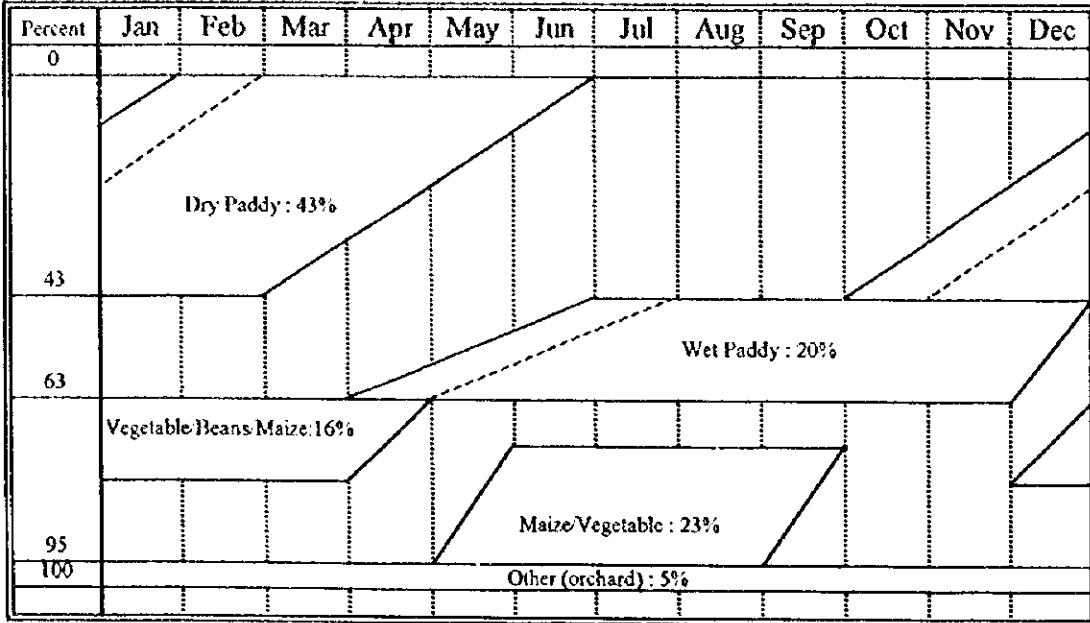
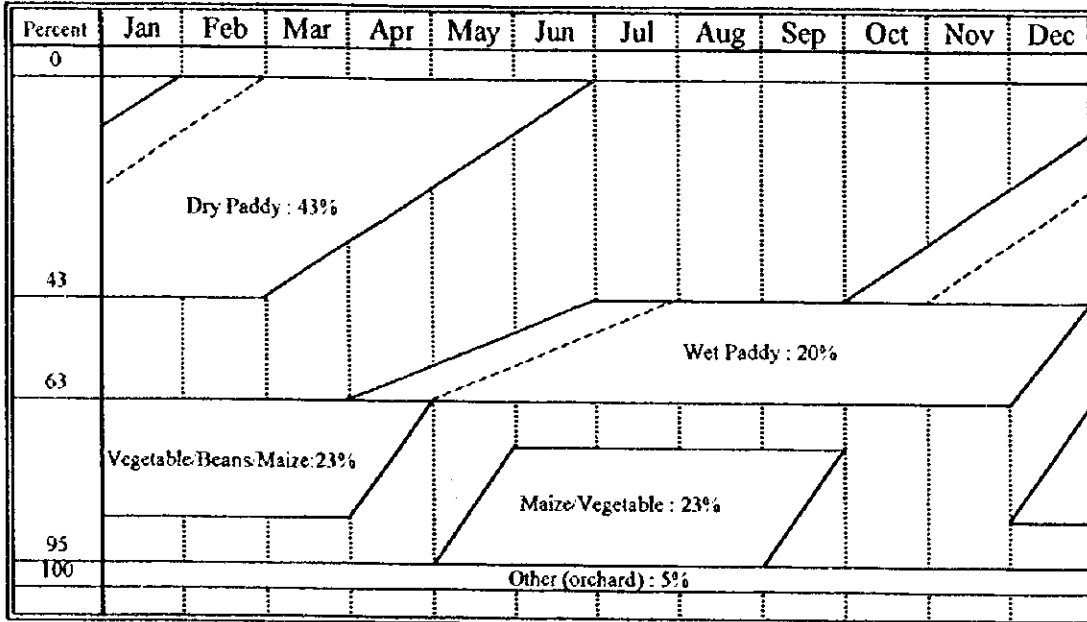


Figure 1.1 Location of the Colmatage Farming Improvement Project

PRESENT CROPPING PATTERN



PROPOSED CROPPING PATTERN



Source: JICA Study Team

Figure 2.1 Present and Proposed Cropping Pattern

Table 1.1 Inventory of Colmatage Canal in the Priority Area

Prek No.	Zone	Name of Prek	Name of Main Village	Number of Village	Number of Families	Canal Dimension			Bridge / Culvert			Gate		Water Source	Problem / Comment						
						Top Width (m)	Bottom Width (m)	Depth (m)	Length (m)	Type (Plan)	B/C/W or None	B (m)	H (m)			L (m)	Rehabilitation	H (m)	Span (m)		
A. Right Bank of the Mekong River, Kean Svay District																					
KS19	I	Spean Prek Pol	Kandul Krom	1	250	15.0	10.0	3.0	2,000	C	C	7.0	7.0	11.4	No need	6.4	1.7	3	Mekong	Reh. is Proposed by Japan. grant aid	
KS15	I	Prek Youm	Prek Youm, Pol	2	1,060	25.0	8.0	6.0	3,000	E	C	10.0	6.3	20.0	No need	3.0	2.5	4	Mekong	Reh. is Proposed by Japan. grant aid	
KS20	I	Prek Chrey		1	418	Incomplete			0	A	None	-	-	-	No need	-	-	-	Mekong	Reh. is Proposed by Japan. grant aid	
KS21	I	Samrong Thom	Reang Dak, Koki Thom	1	589	25.0	7.0	5.0	2,150	D	C	7.0	6.0	12.0	No need	4.0	2.1	3	Mekong	Reh. is Proposed by Japan. grant aid	
KS14	I	Koki Thom		3	1,054	30.0	15.0	2.0	2,800	E	C	8.0	5.3	10.7	No need	5.3	1.8	3	Mekong	Reh. is Proposed by Japan. grant aid	
KS22	I	Prek Kompong Thom	Kbal Chroy	1	555	20.0	10.0	3.0	2,000	D	C	5.8	4.0	8.7	No need	4.0	2.3	3	Mekong	Reh. is Proposed by Japan. grant aid	
6		Sub-total of (A.)		9	3,926	(23.0)	(10.0)	(3.8)	11,950												
(Average)																					
B. Left Bank of the Bassac River, Saang District																					
SA65	IV	Thmei	Chong Koh Tod	1	274	20.0	18.0	2.0	2,000	D	W	3.0	3.8	23.0	Need	-	-	-	Bassac	Water gate structure, Canal. Reh. needed	
SA66	IV	Ta Te	Phum Ta Lone	1	248	20.0	11.0	2.0	2,000	C	C	3.5	3.5	23.6	Need	-	-	-	Bassac	Water gate needed	
SA67	IV	Kranh	Phum Ta Lone	1	192	20.0	17.0	2.0	2,000	D	C	4.0	3.5	19	Need	-	-	-	Bassac	Water gate needed	
SA68	IV	Wath Talong	Phum Ta Lone	1	267	20.0	18.0	2.0	1,800	D	Backfill	-	-	-	Need	-	-	-	Bassac		
SA69	IV	Ta Prak	Prek Ta Prak	1	239	20.0	12.0	2.0	2,000	C	Backfill	-	-	-	Need	-	-	-	Bassac		
SA70	IV	Reussei Srok	Reussei Srok	1	182	20.0	12.0	2.0	2,000	C	C	3.0	3.0	2.5	No need	-	-	-	Bassac		
SA71	IV	Chkaikvein	Phum Chkaikvein	2	235	14.0	5.0	2.0	800	A	C	3.5	8.0	16.0	Need	-	-	-	Bassac	Water gate, Reh. needed	
SA72	IV	Phon	Phum Phon	1	93	10.0	5.0	2.0	800	A	S	6.0	1.8	15.0	No need	-	-	-	Bassac		
8		Sub-total of (B.)		9	1,730	(18.0)	(12.3)	(2.0)	13,400												
(Average)																					
C. Right Bank of the Bassac River, Saang District																					
SA12	IV	Thei	Phum Prek Thei	2	330	40.0	20.0	5.0	2,350	E	C	5.0	8.0	36.0	Need	-	-	-	Bassac	Reh. Plan has designed, W.G. needed	
SA13	IV	Nakia Samrong	Prek Somrong	2	220	25.0	12.0	2.0	1,000	D	S	4.5	3.0	12.0	No need	-	-	-	Bassac		
SA14	IV	Long	Prek Somrong	2	340	30.0	13.0	3.0	1,560	D	S	4.3	4.0	12.0	No need	-	-	-	Bassac		
SA15	IV	Kseiv	Kseiv	2	250	20.0	11.0	2.5	1,500	C	S	4.3	3.0	12.0	Need	-	-	-	Bassac	Reh. Plan has designed, W.G. needed	
SA16	IV	Penn	Phum Kseiv	2	80	20.0	11.0	2.0	800	C	Backfill	-	-	-	Need	-	-	-	Bassac		
SA17	IV	Toch	Prek Roun	2	780	30.0	16.0	3.0	5,000	D	C	5.6	3.5	7.8	Need	-	-	-	Bassac	Reexcavation/Water gate needed	
SA18	IV	Me Srok	Prek Snook	2	130	12.0	4.0	2.0	1,715	A	C	6.0	3.8	12.0	No need	-	-	-	Bassac		
7		Sub-total of (C.)		14	2,130	(25.3)	(12.4)	(2.8)	13,925												
(Average)																					
21		Total of (A.) - (C.)		32	7,786	436.0	235.0	54.5	39,275												
(Average)																					

Note : Bridge Type : C = Concrete, S = Iron, W = Wooden, Cul = Culvert, None = Nothing

Table 1.2 Administrative Status of Villages in the Study Area

District	Commune	Village	Population	No. of Households	Averaged Family Siz	Averaged Farm Size	No. of DDC	No. of CDC	No. of VDC
Kean Svay	Bontey Dek	Kandal Krom	1,325	250	5.30	1.12 ha	1 DDC	2 DDC	1
	Samrong Thom	1-2	5,618	1,060					1
	Koki Thom	1-2-3	5,586	1,054					1
	Kompong Pnom	Prek Kompong Pnom	2,941	555					1
		Sub-Total	15,470	2,919				2	4
Saan	Ta Lone	Chong Koh Ted	1,480	274	5.4	1.06 ha	1 DDC	No	0
	Ta Lone	Phum Ta Lone	2,376	440					0
	Roca Kpous	Phum Prek Thei	1,782	330					0
	Roca Kpous	Kseiv	1,350	250					0
	Prek Koy	Prek Stok	702	130					0
		Sub-Total	7,690	1,424				1	0
		Total	23,160	4,343	5.33	1.11 ha	2	2	4

Table 3.3 Financial Analysis for the Typical Farm

Colmatage Priority Area

Farm Size:1.11 ha

Farm Model-without Project

1. Crop Production

	Area (ha)	Yield (kg/ha)	Production (kg)	Unit Price (Riels/kg)	Value (Riels)	Production Cost(Riels)	Net Income (Riels/ha)
Dry season paddy irrigated	0.60	3,300	1,980	316	625,680	208,232	417,448
Maize	0.28	1,400	392	257	100,744	96,261	4,483
Vegetables	0.30	4,900	1,470	1,000	1,470,000	294,632	1,175,369
Total	1.18						1,597,300

2. Fishery Income(Riels/year)	528,600
3. Off-farm Income(Riels/year)	606,000
4. Total Income(Riels/year)	2,731,900
5. Living Expense(riels/year)	1,288,600
6. Disposable Income(Riels/year)	1,443,300

Farm Model-with Project

1. Crop Production

	Area (ha)	Yield (kg/ha)	Production (kg)	Unit Price (Riels/kg)	Value (Riels)	Production Cost(Riels)	Net Income (Riels/ha)
Dry season paddy irrigated	0.60	4,200	2,520	316	796,320	273,473	522,847
Maize	0.28	1,700	476	257	122,332	103,821	18,511
Vegetables	0.38	5,400	2,052	1,000	2,052,000	430,260	1,621,740
Total	1.26						2,163,098

2. Fishery Income(Riels/year)	861,089
3. Off-farm Income(Riels/year)	987,174
4. Total Income(Riels/year)	4,011,361
5. Living Expense(riels/year)	2,099,129
6. Disposable Income(Riels/year)	1,912,232

Table 2.1 Agricultural Land Use and Production Plan

Location	Project	Farmland (ha)				Cropping Distribution (%)						Planted Area (ha)				Total
		Paddy		Upland		Paddy		Upland		Paddy		Upland		Upland		
		Dry Season	Wet Season	Total	Upland	Dry Season	Wet Season	Total	Upland	Dry Season	Wet Season	Total	Upland	Dry Season	Wet Season	
Kean Svay Saang	Without	1,906	610	2,345	4,861	43	20	16	23	5	107	778	1,118	243	5,201	
	With	1,906	610	2,345	4,861	43	20	23	23	5	114	1,118	1,118	243	5,542	

PRODUCTION

Location	Project	Paddy Production (ton)			Upland Crops Production (ton)			Total Production
		Dry Season	Wet Season	Total	Dry Season	Wet Season	Total	
Kean Svay Saang	Without	6,898 (100%)	2,333 (100%)	9,231 (100%)	1,773 (100%)	2,247 (100%)	4,021 (100%)	13,252 (100%)
	With	8,779 (127%)	2,819 (121%)	11,598 (126%)	3,008 (170%)	2,454 (109%)	5,462 (136%)	17,060 (129%)

PADDY PRODUCTION

Location	Project	Dry Season Paddy				Wet Season Paddy			
		Major Varieties	Average Yield (ton/ha)	Planted Area (ha)	Production (ton)	Major Varieties	Average Yield (ton/ha)	Planted Area (ha)	Production (ton)
Kean Svay Saang	Without	IR36, IR42, IR66	3.3 (100%)	2,090 (100%)	6,898 (100%)	Traditional, IR42	2.4 (100%)	972 (100%)	2,333 (100%)
	With	IR66, IR72, IR Kesar	4.2 (127%)	2,090 (100%)	8,779 (127%)	Traditional, Santheep 1-3	2.9 (121%)	972 (100%)	2,819 (121%)

UPLAND CROPS PRODUCTION IN DRY SEASON

Location	Project	Vegetables (35%)				Beans (55%)				Maize (10%)			
		AVG. Yield (ton/ha)	Area (ha)	Production (ton)	AVG. Yield (ton/ha)	Area (ha)	Production (ton)	AVG. Yield (ton/ha)	Area (ha)	Production (ton)	AVG. Yield (ton/ha)	Area (ha)	Production (ton)
Kean Svay Saang	Without	4.7 (100%)	272 (100%)	1,279 (100%)	0.9 (100%)	428 (100%)	385 (100%)	1.4 (100%)	78 (100%)	109 (100%)	778 (100%)	1,773 (100%)	
	With	5.5 (117%)	391 (144%)	2,152 (168%)	1.1 (122%)	615 (144%)	676 (176%)	1.6 (114%)	112 (144%)	179 (164%)	1,118 (144%)	3,008 (170%)	

UPLAND CROPS PRODUCTION IN WET SEASON

Location	Project	Maize (85%)				Vegetables (15%)				
		AVG. Yield (ton/ha)	Area (ha)	Production (ton)	AVG. Yield (ton/ha)	Area (ha)	Production (ton)	AVG. Yield (ton/ha)	Area (ha)	Production (ton)
Kean Svay Saang	Without	1.5 (100%)	950 (100%)	1,425 (100%)	4.9 (100%)	168 (100%)	822 (100%)	1,118 (100%)	1,118 (100%)	2,247 (100%)
	With	1.7 (113%)	950 (100%)	1,616 (113%)	5.0 (102%)	168 (100%)	839 (102%)	1,118 (100%)	1,118 (100%)	2,454 (109%)

Source: JICA Study Team

Table 2.2 Cost Estimation of Rehabilitation for Colmatage Canal in the Priority Area

(Unit : US\$)

District Name	Type of Colmatage Canal	Existing Canal		Cost of Implementation Works										Remarks
		Number	Canal Length (m)	Gate (Nos.)	Proposed canal		Intake Gate		Bridge		Total (US \$)			
					Number	Length (m)	Amount (US \$)	Number	Amount (US \$)	Number		Amount (US \$)		
A. Right Bank of the Mekong River														
	A	1	-	-	-	-	-	-	-	-	-	-	-	
	B	-	-	-	-	-	-	-	-	-	-	-	-	
Kean Svay	C	1	2,000	1	2,000	155,128	1	269,274	-	-	-	-	424,402	
	D	2	4,150	2	4,150	398,448	2	1,028,893	-	-	-	-	1,427,342	
	E	2	5,800	2	5,800	680,886	2	1,418,351	-	-	-	-	2,099,237	
	Sub - total	6	11,950	5	11,950	1,234,463	5	2,716,519	-	-	-	-	3,950,981	
B. Left Bank of the Bassac River														
	A	2	1,600	-	-	-	-	-	-	-	-	-	19,492	
	B	-	-	-	-	-	-	-	-	-	-	-	-	
Saang	C	3	6,000	3	6,000	465,384	-	-	-	-	-	-	543,815	
	D	3	5,800	3	5,800	556,868	-	-	-	-	-	-	686,576	
	E	-	-	-	-	-	-	-	-	-	-	-	-	
	Sub - total	8	13,400	-	11,800	1,022,252	-	-	-	-	-	6	227,630	1,249,882
C. Right Bank of the Bassac River														
	A	1	1,715	-	-	-	-	-	-	-	-	-	-	
	B	-	-	-	-	-	-	-	-	-	-	-	-	
Saang	C	2	2,300	2	2,300	178,397	-	-	-	-	-	2	78,431	256,828
	D	3	7,560	3	7,560	725,848	-	-	-	-	-	1	43,236	769,084
	E	1	2,350	1	2,350	275,876	-	-	-	-	-	1	60,953	336,829
	Sub - total	7	13,925	6	12,210	1,180,122	-	-	-	-	-	4	182,619	1,362,741
	A	4	3,315	-	-	-	-	-	-	-	-	1	19,492	19,492
	B	-	-	-	-	-	-	-	-	-	-	-	-	
Total	C	6	10,300	1	10,300	798,909	1	269,274	-	-	-	4	156,861	1,225,045
	D	8	17,510	2	17,510	1,681,165	2	1,028,893	-	-	-	4	172,944	2,883,002
	E	3	8,150	2	8,150	956,763	2	1,418,351	-	-	-	1	60,953	2,436,067
	Grand - total	21	39,275	5	35,960	3,436,837	5	2,716,519	10	410,249	-	10	410,249	6,563,605

Table 3.1 Incremental Agricultural Benefits

-Colmavtage Priority Area -

	Wet Season		Dry Season		Orchard (Banana)	Total
	Vegetables		Vegetables			
	Paddy	Maize	Paddy	Maize		
Without Project						
Yield(kg/ha)	2,400	1,500	4,900	900	4,700	6,200
Unit Price(Riels/kg)	334	261	1,000	1,700	1,000	350
Gross Production Value(Riels/ha)	839,520	391,500	4,900,000	1,530,000	4,700,000	
Cost of Production(Riels/ha)	155,467	324,928	872,068	379,726	872,068	
Net Production Value(Riels/ha)	684,053	66,572	4,027,932	1,160,274	3,827,932	1,807,544
Planting Area(ha)	972	950	168	428	272	243
Total NPV(Million Riels)	665	63	677	497	1,041	439
With Project						
Yield(kg/ha)	2,900	1,700	5,400	1,100	5,500	7,800
Unit Price(Riels/kg)	334	261	1,000	1,700	1,000	350
Gross Production Value(Riels/ha)	1,014,420	443,700	5,400,000	1,885,000	5,500,000	
Cost of Production(Riels/ha)	167,587	364,486	885,063	348,876	441,326	1,022,753
Net Production Value(Riels/ha)	846,833	79,214	4,514,937	1,443,674	4,477,247	2,085,175
Planting Area(ha)	972	950	168	112	391	242
Total NPV(Million Riels)	823	75	759	888	1,751	507
Incremental Benefit(Million Riels)	158	12	82	391	709	67

Note: NPV per hectare includes income from by-products

Yield of banana is in number of hands.

Table 3.2 Project Cost

	Project Cost (US\$)		Project Cost (million Riels)	
	Financial Cost		Economic Cost	
	LC	FC	LC	FC
1. Construction Cost				
a) Right bank of the Mekong River	573,941	2,691,333	286,971	2,691,333
b) Left bank of the Mekong River	435,675	597,285	217,838	597,285
c) Right bank of the Bassac River	465,284	660,948	232,642	660,948
Sub-Total	1,474,900	3,949,566	737,450	3,949,566
2. Project Administration	0	0	0	0
3. Consulting Services				
1) Detail design	216,979	216,979	0	216,979
2) Construction supervision	325,468	325,468	0	325,468
Sub-Total	542,447	542,447	0	542,447
4. Agricultural Supporting Activities	0	0	0	0
5. Physical Contingency	596,691	147,490	298,346	449,201
Total	6,563,604	1,622,890	4,941,214	15,773,539

**PART 2 FEASIBILITY STUDY FOR THE
PRIORITY PROJECT AREAS**

**II. AGRICULTURAL DEVELOPMENT PROJECT
HARMONIZED WITH FISHERIES IN THE PRIORITY
AREA**

CHAPTER 1 PRESENT CONDITIONS

1.1 Natural Conditions

1.1.1 Location

The Phtea lake area, about 25 km northeast of Phnom Penh, is located in the left bank of Mekong river in Srok Ksach Kandal. The Study Area covers 6,130 ha.

1.1.2 Topography

The stretches of natural levee along the left bank of Mekong river and the Phras Konlong road and the villages are 8-10 m in elevation. To the east of the Phtea lake, the six (6), seven (7) and eight (8) m contour lines are closer together, indicating that there is a steep slope fringing the lake. The Phtea lake is 'linked' to Boeng Tbaung and Kheho through the Phras Konlong bridge and the narrow stretch of land below EL. six (6) m under the bridge. To the west of the Phtea lake, the six (6), seven (7) and eight (8) m contour lines are wider and more irregular, indicating gentler slopes and considerable variations in topography. The northern end (Svay Att Leu village) of the Study Area is higher in elevation, over EL. nine (9) m. The land descends and gradates southward toward the Phtea lake. The outlet of the lake is long and narrow, expanding to a large area of land below EL. five (5) m around the fish trap near Peak Kdam reservoir (see Figure 1.1).

On the whole, the Study Area has a concave topography, with the Phtea lake, below EL. five (5) m, being the center of the concavity. Many reservoirs, mostly located below the seven (7) m contour lines, are found in the periphery of the Phtea lake.

Geologically, young alluvium is underlain. The surface of ground is consisted of clay, silt and laterite. It is soft and low infiltration, become muddy soil with rain or flooded water.

1.1.3 Hydrometeorology

(1) Meteorology

Basic meteorological data has been collected from the Pochentong Station (see Figure 1.2). The rain/wet season (May-November), under the influence of the Southwest Monsoon, is characterized by a relatively lower temperature, high rainfall intensity, lower evapotranspiration demand, high humidity and shorter sunlight hours. The dry season (December-April), under the influence of the Northeast Monsoon, is the exact opposite: hot, dry, sunny and less humid.

Mean monthly temperature ranges from 25°C (Dec.) to 29.7°C (April). Mean relative humidity is high throughout the year, over 67%, with mean daily range varying from 16% (Oct.) to 25% (May). Evaporation varies from 3.6 mm/day (Sept.) to 7.3 mm/day (March).

Annual rainfall ranges from 1,095 mm (1992) to 1,552 mm (1987), averaging 1,279 mm (see Figure 1.3). Over 90% of rainfall occur in the wet season. Average monthly rainfall during wet season ranges from 102 mm (November) to 282 mm (September). In the dry season, the average monthly rainfall is less than 5 mm. Total monthly rainy day (defined as daily rainfall 1

mm) in wet season ranges from 6.6 days (November) to 16.6 days (September). During dry season, the range is 0.2-4.4 days. The annual average is 94.6 days.

The average values of 1-, 2- and 3-day rainfall are 88.8, 107.0 and 122.0 mm, respectively. Over 40% of the 1-, 2- and 3-day rainfall occur in August and September. The occurrence in May is over 20%.

Only about 53% of annual rainfall are effective for rice cultivation defined as 80% of 5 to 80 mm/day. Since most of the rainfall occurs in the wet season, the difference between the wet season and annual total is small, only 4%. Rainfall intensity in wet season can be well over 80 mm, resulting in only 49% of rainfall being effective.

(2) Hydrology

Chrouy Changvar is the nearest gauging station for the Study Area. It was chosen as the reference station for inundation analysis. The annual water level begins to rise in May, peaks in September and declines in October (see Figure 1.4). The rising rate is high in June-August and the falling rate is high in October-December. About 60% of the peak level occurred within a narrow band of one (1) m (0.5 m of the mean peak 8.89 m) and 90% within a band of two (2) m (1.0 m of the mean peak value). The mean range (peak-minimum level) is about 8.25 m.

The table below shows the peak flood level of different return period for Chrouy Changvar. The year 1985 and 1966 were chosen as the typical year, based on the peak level, to represent monthly flood phenomena for 1/2 and 1/10 return period (R.P.). The water level in the Study Area for the respective return periods is assumed to be 0.5 m higher, tied in to the daily water level of Chrouy Changvar.

Peak Flood Level	
	unit:(EL. m)
1/2 return period	8.83 (1985 peak level 8.84)
1/10 return period	9.97 (1966 peak level 9.94)
1/25 return period	10.45
1/50 return period	10.78
1/100 return period	11.09

1.1.4 Inundation Conditions

(1) Direction of Flood Flow

The general direction of water-flow in and out of the Study Area is shown in Figure 1.1. The major colmatage canals along Mekong river, Agn Cheng, Tamao and Kong Van, deliver flood water to the Phlea lake and the adjoining reservoirs, submerging the fields and flooding the forest when water level in Mekong and the colmatage canals reach the threshold level assumed to be six (6) m in this study. Flood water also flows in from Boeng Khcho through Phras Konlong bridge, the smaller bridges and crossing structures along the Phras Konlong road. Through the Ta Gnel canal, some water is channeled from Tonle Toch. In some parts of the

area, flooded water intrudes from south during wet season with backwater of the Mekong river. Late in the wet season, most of the flood water recedes southward through the long and narrow outlet into Boeng Veal Sannap in Lovea De district, a large lake to the south that flows into Tonle Toeh.

(2) Inundated Area

In July of 1985 flood level was EL. 6.22 m, resulting in 7% of land inundated to 3-4 m deep, 8% to 2-3 m, 25% to 1-2 m and 3% to 0-1 m. Inundation depth varied with flood level, i.e., the 6-5 m elevation band was inundated at different depths of 1-2 m in July, 2-3 m in August, 4-5 m in September, 3-4 m October and 1-2 m in November. In 1966, inundation followed a similar pattern: In July, August and December inundation were less severe. The higher flood level in September-November resulted in wider and deeper inundation (see Figure 1.5).

In 1985 (1/2 R.P.), 43% was inundated in July, 64% in August, 88% in September, 76% in October, 45% in November and 15% in December when the flood receded. Inundation was confined mainly to the water body of the Phtea lake from January to June. In 1966 (1/10 R.P.) inundation followed similar trend, except for September when the inundation covered a wider area, or 95% of total land area.

In July only, the area below EL. six (6) m in the periphery of the Phtea lake was inundated. As the flood advanced, the extent of inundation became wider, covering over 88% and 95% in September of the respective years. As the flood receded, land in the higher elevation re-surfaced. By the end of December, water was found mainly in the Phtea lake (see Figure 1.6).

1.1.5 Soil

Soil survey for the Study Area has not yet been conducted. Considering the Soil Map (1:500,000) obtained from LUMO, MAFF, the Study Area comprises three major soil units, namely Brown Alluvials, Alluvials and Cultural Hydromorphics (see Figure 1.7).

These three soil units are not major constraints for agricultural production. The two alluvial soil units covering more than 90% of the Study Area are rather productive ones in Cambodia. The soil distributions and the general characteristics of these soil units are as follows;

1. Brown Alluvials: 2,000 ha (33%)

These coarser-textured soils are distributed along the Mekong River banks. They are economically quite significant and have different production potential from the finer-textured slake-water alluvials.

2. Alluvials: 3,990 ha (65%)

The fresh-water alluvial deposits are geologically recent deposits of effluents in which pedological processes of soil formation have not gone on enough to make significant pedological horizon differentiation.

3. Cultural Hydromorphics: 140 ha (2%)

This soil has a thin, artificially compacted, impermeable horizon resulting from development into rice fields. While these soils are classified on the basis of recent cultural usage, the shallow impermeable compacted layer of the soil has

effect on the physical and production characteristic of these soils.
(Note; Area measurement data are based on the Soil Map scaled up to 1:50,000.)

Considering the field survey, the Brown Alluvials seem to be narrower than the map indication and the Cultural Hydromorphics seem to be distributed more broadly to the east part of the Study Area. Field survey also reveals that acid sulfate soil, which is occasionally observed in the tropic and becomes one of the agricultural constraints, is unknown in the Study Area.

1.1.6 Land Use

Land use in the Study Area is classified into the following six categories; farmland, reservoir /inundated forest, waste/grass/bush land, river/lake, residential land and road/canal. According to the field survey and the topographic map (1:10,000), the present land use map is drawn and the areas of each land use category are measured (see Table 1.1 and Figures 1.8 and 1.9).

Farmland has the largest area, 3,565 ha or 58% in the Study Area. This is followed by the waste/ grass/bush land representing 18% (1,127 ha). These two categories occupy almost three-fourths of the Study Area.

The distribution of these land use categories primarily depends on land elevation, in other words, flooding period. Low land areas usually receive longer period of flood than high land areas, so intensive land use is impossible. Low land areas mainly include waste/grass /bush land, river/lake, reservoir/inundated forest, and the part of farmland for dry season recession paddy. The land below EL. eight (8) m height occupies 64% of the Study Area. On the other hand, high land areas are used intensively as residential lands, orchards and some upland crop farmland.

Among the six categories, waste/grass/bush land, the second largest distribution, includes some farmland, shrubs and unutilized areas. They are classified under one land category because their distribution is very complicated. Usually, this land use category corresponds to lands between EL. six (6) to EL. eight (8) meters high, which receives from two (2) to four (4) months flooding period.

Most of the reservoir/inundated forest is surrounded by artificial dike. The natural vegetation in reservoir is abundant. The stored floodwater in reservoir is usually used for irrigation of dry season recession paddy. The vegetation in reservoir supplies firewoods for village people. It also provides fish habitat during inundated period. Thus, the reservoir has multipurpose usage. Recently, inundated forests seem to be decreasing gradually due to continuous cutting for firewood collection and clearing for development of new farmland.

The land use of farmland is furthermore classified into four sub-categories by farming. Details are described in "1.3.1 Agricultural Land Use".

1.2 Socio and Agro-Economy

1.2.1 Administration

There are 18 communes in Ksach Kandal district, 11 of which are located along the Mekong river and two (2) along Tonle Toch.

Administratively, the Phtea lake area belongs to Ksach Kandal district of Kandal province. It covers five (5) communes which are composed of 20 villages. The Study Area contributes about 20% to Ksach Kandal district in acreage (see Table 1.2).

The district office has 17 sections under the district governor (see Figure 1.10). Organization of communes is generally divided into four (4) sections under a chief of commune, in which four vice-chiefs are assigned to perform duties for the commune people (see Figure 1.11).

In the Study Area, one DDC in Ksach Kandal district, 5 CDC and 20 VDC are currently in existence (refer to Table 1.2).

1.2.2 Population

The population of the Study Area is estimated at 27,033 with 4,992 households with an average family size of 5.42. It is notable that 59% out of 500 farm households interviewed for the Rural Socio-economic Survey is categorized as female headed family. Population density is 552 (refer to Table 1.2).

In the Study Area, the residential areas are mainly located in the villages along the Mekong river at the western area and in the inland villages located at the eastern area. The former is more populated than the latter. This is probably due to water availability for both domestic and irrigation uses.

1.2.3 Food Security

Paddy/rice is the most important crop as it is the staple food in Cambodia. The categories for classifying farmers (Halcrow) are as follows:

- a) **Rich household:** more farmland to produce enough rice for home consumption with better yield, earns money to buy fertilizer and draft animal, and with less debt,
- b) **Poor household:** not enough rice for home consumption but earn money through secondary activities to meet rice deficit,
- c) **Marginal household:** not enough rice for home consumption and does not earn sufficient money through secondary activities. They have to borrow rice and/or to reduce their food intake below standard requirement.

Excluding farmers living in the area along the Mekong river, most farmers in the Study Area deal with mono-culture of paddy planting during wet or dry season. Annual harvested areas have been affected by flood or precipitation. This has resulted to low yield and far from self-sufficiency of paddy in the Area.

Food security should be considered at two levels, that is, regional basis and individual farm household basis. For the former, the study by WFP/FAO provides useful information on the self-sufficiency of paddy. According to this, paddy productions in the five (5) communes concerned to the Study Area do not meet requirement, causing about 1,900 ton deficit (refer to Table 1.3).

As for the latter, individual farm household, both farm size and location of farmlands are the major factor for food security. The average farm size in the Study Area is 0.9 ha. Considering an average paddy yield and annual per capita paddy consumption of 253 kg and family size of 5.42, an average farm size must be at least bigger than 1.0 ha or paddy must be harvested two times a year to meet its family consumption. However, only 43% of farm households meet its family demand according to the result of the Rural Socio-economic Survey. Taking account of the above consideration, attainment of food security in the Study Area would be difficult.

Here, water availability at the farm households along the Mekong river must be mentioned again from the viewpoint of advantage for potential year-round farming. The farm households along the Mekong river can irrigate their farmlands by using pump throughout the year. This means stable production of paddy and other crops, implying higher incomes compared to farmers dealing with single culture of paddy.

1.2.4 Farmland Holding

In the Study Area farmlands were distributed gratuitously to farmers in 1987. The district governor first instructed to Krom Samaki (farmer's group, which was composed of 8 to 10 families but now abolished), to distribute lands. The members of Krom Samaki discussed the equitable distribution until they could agree among members. If they had problems, district office mediated.

Farm sizes distributed to farmers along the Mekong river were 0.3 to 0.5 ha per family. Inland farmers were given 0.5 to 2.5 ha based on their family size and water availability. After the agreement, the land title office of the district prepared distribution map of individual farmland and then governor issued a certificate. Land distribution was finished in 1987. However, after land distribution, some farmers sold or rented out their lands. About 3% of farmers are now categorized as landless in Ksach Kandal district.

1.2.5 Farm Economy

Ksach Kandal district is composed of 18 communes with five (5) communes classified as poor as compared to the other 13. In the five (5) poor communes only wet season paddy can be planted once a year with its productivity dependent on unstable annual flood and precipitation. These resulted in the disparity not only in incomes but also literacy rate, home industry technology, etc.

Considering farm size, rainfed agriculture and consumption of paddy, farm economy in the Study Area is characterized as subsistence farming. As mentioned above, five (5) out of 18 communes in Ksach Kandal are classified as poor commune. The two (2) communes of Sanlung and Vihearsour belong to this poor group. These two (2) communes are located inland, far from the Mekong river. It is speculated that most farmers in the Study Area live on incomes below the poverty line of 2.2 million Riels (820 US\$) per year per family. The

average annual family agricultural income is 776,300 Riels while total annual family income including off-farm income is 1,347,000 Riels (480 US\$).

In the field of agricultural credit, GRET works by providing 35\$ per household for 615 farm households, 3% of the total households in Ksach Kandal district. Some 32% of farmers interviewed in the Rural Socio-economic Survey are in debt.

1.3 Agriculture

1.3.1 Agricultural Land Use

Based on the field survey, there is a general relationship between agricultural land use and land elevation in the Study Area, as follows;

<u>Land Elevation (EL. m)</u>	<u>Main Agricultural Land Use</u>
> 9	Orchard, Upland crops
9-8	Upland crops, Irrigation paddy
8-6	Rainfed paddy, Recession paddy
< 6	Recession paddy

In the Study Area, there are more than 3,500 ha of farmland, which represent 58% of the whole Study Area. Farmlands are classified into four major agricultural land use categories, namely recession paddy (dry season paddy utilizing flood recession water) 1,622 ha.; irrigation paddy (wet season paddy with supplemental irrigation) + upland crops, 817 ha.; rainfed paddy (wet season paddy with only rainfed water) 1,052 ha.; and orchard, 74 ha (see Figure 1.8, 1.16 and Table 1.4).

The area of recession paddy occupies 45% of total farmland. It is exclusively distributed to lands below eight (8) m high and most fields are less than six (6) m high. This category is normally situated around reservoir, which provides supplemental irrigation water, although stored floodwater is sometimes not enough. Fields are usually planted only once a year because of prolonged flood and lack of water after harvesting.

In the area of irrigation paddy + upland crops' category, two kinds of crops are cultivated. Double/triple croppings are somewhat conducted. This category occupies about 23% of total farmland. Most of the land is situated above EL. eight (8) m height. This category is mainly distributed around the residential land along the Mckong. It has a wide variety of crops because the farmers can easily obtain irrigation water by pumping up from the Mckong and the colmatage canals. Some farmers also irrigate paddy by pumping in the beginning of wet season when it rains sporadically. On the other hand, in the villages of Vihearsour, upland crops are cultivated around the houses for home consumption due to the difficulty of securing irrigation water.

The rainfed paddy area is distributed in two eastern communes, Vihearsour and Sanlung. About 30% of total farmland correspond to this category. In these two communes, rainfed paddy is the main farming activity. The farmland of this category usually does not receive floodwater, or if receives, flood period is very short, so recession paddy is generally impossible.

Orchard is mainly cultivated for home consumption on the bank of the Mekong in the western part of the Study Area and around the houses in the eastern part. The planted area is very small, 74 ha, which represents only 2% of total farmland.

Some of the swamps, reservoirs and lakes are also used for lotus and mat grass (*Scirpus grossus* L. f. and *Cyperus difformis*) field but these areas can neither be clarified nor be measured. They are included in the three (3) categories; lake/river, reservoir/inundated forest and waste/grass/bush land.

1.3.2 Crops and Farming Practices

(1) Crops

According to the Rural Socio-economic Survey, 491 farmers out of 500 have paddy field. The average paddy field area is 0.92 ha (see Table 1.5). Findings reveal nine (9) farmers without paddy field, but with upland field (0.2-0.7 ha). Six (6) of farmers practice tenant farming for paddy. Some 22 respondents earn more money from fishing than from farming activity though all of them actually practice farming (see Table 1.6).

About half of the interviewed farmers practice both dry and wet season paddies. Farmers practicing only dry season paddy comprise about 30% while those practicing only wet season paddy include about 20%. In Prek Tamerk and Prek Ampil, farmers practicing only dry season paddy are dominant, 64% and 71%, respectively. On the other hand, farmers practicing only wet season paddy are dominant in Sanlung, 88%. Farmers practicing both dry and wet season paddies are common in Vihearsour, 84%. In Puk Reusei, there are three types of paddy practicing farmers each type composed of 26 to 39% (see Table 1.7).

The result of the survey reveals that 20 upland crops are practiced in the Study Area. Generally, upland crops farming are more common during dry season than during wet season. During the dry season, 17 upland crops are cultivated by 144 farmers with about 137 farmers located in Prek Tamerk and Puk Reusei. Mat grass is the most popular crop and practiced by 62 farmers. Mungbean is the second most popular crop cultivated by 21 farmers. Tomato, watermelon and chili follow but all of them are practiced by less than 10 farmers. During the wet season, only nine (9) upland crops are cultivated by 85 farmers and 54 farmers of them are from Puk Reusei. Sesame is the most popular crop and practiced by 33 farmers. This is followed by cassava and maize practiced by 14 and 10 farmers, respectively.

Considering the statistics obtained from district agriculture office, thirteen upland crops are cultivated in the communes concerned. Among them, chili has the largest planted area of 118 ha. However, more than 40% (or 48 ha) of the planted area is in Prek Ampil that occupies only 3% of the Study Area (see Table 1.8).

(2) Farming Practices

Irrigation water availability and degree of flooding determine cropping season in the Study Area. Irrigation paddy + upland crops area along the Mekong usually does not have flood or has only gentle flood. Moreover irrigation water is available all year round by pumping up from the Mekong. So cropping intensity is very high, more than 300% in some fields. These areas are

more than EL. eight (8) m high.

Most areas of recession paddy around the reservoirs receive severe flood. According to floodwater recession, farmers start to transplant paddy seedlings. Supplemental irrigation water is supplied from the reservoirs by gravity. Sometimes the stored water is not enough for growing paddy. Some farmers take water from lower water source such as the Phtea lake by traditional manual irrigation, rohat/snaich, or mobile pumps. Generally, recession paddy area is single cropping.

Rainfed paddies in the eastern part of the Study Area are situated in areas more than EL. eight (8) m high. Hence, the flood condition is almost the same as that of irrigation paddy + upland crop areas. One of the big differences between the two areas is irrigation water availability. Since no permanent water source is available, the cropping intensity in this area is usually less than 100%.

In Puk Reusei, half of both paddy and upland crops practicing farmers sell their farm product. In Prek Tamerk and Sanlung, the shares of farmers selling paddy are less than 20%. This means that most farmers in these two communes cultivate paddy for self-consumption. Farmers who sell upland crops are more than 50%. On the other hand, in Vihearsour and Prek Ampil, farmers tend to sell paddy but cultivate upland crops for self-consumption (see Figure 1.17).

Considering the results of the Rural Socio-economic Survey, self-keeping paddy seeds for production is customarily used for nursery. Farmers who renew paddy seed are very few, estimated as less than 10%. During the wet season, the average amount of seed for nursery is 120 kg/ha. This figure is almost the same in the five (5) communes. During the dry season, it is 134 kg/ha but the figure ranges from 127–170 kg/ha (see Tables 1.9 and 1.10, Figure 1.18).

Urea is the only commonly applied fertilizer in both wet and dry seasons. During the wet season, it is also used in the three communes along the Mekong, Prek Tamerk, Puk Reusei and Prek Ampil. The average amount of application ranges from 84–181 kg/ha. In the dry season, 90% of farmers (324/365) use urea. Particularly, the using rate in Vihearsour increases from 34% to 77%. The amount of application ranges from 90–181 kg/ha.

Agricultural chemicals are not commonly used. However, about one fourth of the farmers applies them in wet season. The number of farmers using chemicals increases to 50% in dry season. Methyl parathion and mevinphos are the two common insecticides used in both wet and dry seasons. Farmers get farming information such as application method of fertilizer/agricultural chemicals from neighbors (452/500) and extension officers (272/500).

For wet season paddy, farmers usually conduct land preparation between June to July and transplant seedlings between July and August. Harvesting season varies from October to December because the growth period depends on the planted variety. On the other hand, farming practice in the dry season paddy is conducted according to the recession of floodwater. So the period of each farming practice becomes one-month longer. Generally, land preparation is conducted between October to December, transplanting is between November to January, and harvesting is between February to April (see Table 1.11).

According to the Rural Socio-economic Survey, 274 farmers have their draft animal. The average number of animal per family is 2.3 heads. Tractor is used by only one farmer in Puk Reusei. Thresher is mainly distributed in Puk Reusei, 58 machines out of 62. About 55 farmers have hand sprayers and movable pumps, which represents 11% of total (see Tables 1.12 and 1.13).

During field survey, 20 farmers were directly interviewed to get some data on both floods and cropping periods (The interview is completely different from the Rural Socio-economic Survey). According to these, upland crops are generally cultivated on lands higher than BL. eight (8) m while floodwater comes up to almost BL. nine (9) m high. It seems that floodwater comes quickly and recedes slowly. Paddy cropping is adjusted according to the recession of floodwater (see Table 1.14).

1.3.3 Production and Yield

It is difficult to estimate paddy production in the Study Area accurately because of the absence of production statistics by commune. Only the statistics of planted and damaged areas of paddy by commune are available. Hence, communal production is estimated by multiplying the district average yield and communal harvested area based on the planted and damaged area. During the wet season paddy in 1995, the district average paddy yields of early, medium and late variety are 3.0, 2.5 and 2.7 tons/ha, respectively. The yield of dry season paddy in 1994/95 in Ksach Kandal varies from 3.51 to 3.84 tons/ha by variety type (see Table 1.15).

Considering the Rural Socio-economic Survey, the average yields of paddy by cropping season are calculated. The yields of dry season paddy vary from 2.26 to 3.30 ton/ha. There is a tendency for the yield of dry season cropping (3.17 ton/ha) to be higher than that of both dry and wet season croppings (2.77 ton/ha). On the other hand, the yields of wet season paddy vary from 1.27 to 2.93 ton/ha. The yields of wet season paddy in Sanlung and Vihearsour are lower than those of the other communes due to different varieties (see Table 1.17).

The yields of upland crops are also calculated from the results of the Rural Socio-economic Survey. Generally, these figures seem to be exaggerated because some figures are bigger than the district average yield, sometimes more than eight times bigger (see Table 1.16).

1.3.4 Livestock

Livestock plays an important role in the lives of the rural people in terms of labor, income generation and food supply. Large animals such as cattle and buffaloes are generally used for farming. They are used for plowing, harrowing, hauling, etc. They also provide organic natural fertilizer, manure, etc. These animal labors are indispensable for farming since farm machines are not yet available to the farmers.

According to the statistics, cattle are common in the three communes along the Mekong. However, inland two communes have more buffaloes than riverside communes. Pigs and chickens are popularly raised in all five (5) communes (see Table 1.17).

Considering the Rural Socio-economic Survey, 274 farmers have their draft animal, representing 55% of total. The average head raised ranges from 2.1 to 2.4. Pigs are important as sub-

income sources for rural people, hence, are more popular in the four communes except for Prek Ampil. In particular, 24 farmers out of 25 raise pigs in Sanlung. Most of farmers interviewed also breed chickens. They are raised to provide eggs and meat for home consumption (see Table 1.12).

1.3.5 Women in Agricultural Activities

Considering the Rural Socio-economic Survey, there are 520 female full-time farm labors and 435 female part-time farm labors among 500 interviewed families. It indicates that every household has 1.04 full-time and 0.87 part-time female farm labors. The figures of male full time and part-time farm labors are 1.50 and 0.48, respectively. Although the interviewed farm number is small, female labors occupy more than half of total labor force in Sanlung (see Table 1.18).

For a housewife, farming is the most time-consuming task. Survey shows that a housewife works on farm-related activities for 4 hours and 51 minutes per day on the average. This represents a 40% of daily working hours (12 hours) for women (see Figure 1.19).

1.4 Agricultural Supporting Service

1.4.1 Agricultural Extension Service

In the District Agriculture Office located in Knong, Prek Tamerk, the "Agronomy Section" and "Animal Production & Health Section" provide agricultural extension services in the Study Area. The "Agronomy Section" had four employees two years ago. However, two employees attended training but did not come back after training. The vacancy is not yet filled up. At present, both sections have two employees each (see Figure 1.20).

At present, the office conducts monthly meeting/seminar for commune staff. There were four meetings/seminars during the last six months (Jan.-Jun., 1997) and eight meetings/seminars the previous year. Usually, the meeting/seminar consisted of two parts; general and specific subjects. The director conducts the former one while the staff of Agronomy Section conduct the latter one. Due to limited budget, training materials as brochures/textbooks are not available. Only oral lecture is given.

Two staffs of the Animal Production & Health Section prevent the spread of diseases of cattle, buffaloes and pigs with injection. The medicines are distributed through the provincial office. During the last six months (Jan.-June 1997), injections were given to 5 cattle, 12 buffaloes and 94 pigs. They also control the 18 slaughterhouses in the district by monitoring the number of slaughtered animals and collecting tax.

There are short-term training courses for the district staff by the provincial government but they are not held periodically but sporadically.

1.4.2 Post-Harvest, Processing and Marketing

Commercial basis post-harvest activities have not been encouraged except for small-scale village-based 43 rice mills due to subsistence farming in the Study Area. Milling machines are

operated by oil due to absence of electricity. Milling charge is 250 Riels per 10 kg of paddy.

Mat weaving is popular particularly in the villages along the Mekong river. Raw materials for mat making are rush and matgrass, and made by two women on home industry-basis. Merchants come from Phnom Penh to buy mats from villagers. Some of these mats are exported to Thailand. Mat made is 1.2 x 2.1 m in size and price varies depending on quality from 5 US\$ to 10 US\$ each. Two women can usually produce two (2) mats a day.

Some other agricultural processing such as noodle, tobacco, dried chili, sesame cake and smoked fish are made but all of them are small-scale and negligible for the feasibility study in the district.

There are three local markets in Ksach Kandal, Prek Tamerk, Vihearsour and Svay Romeat. Fattening pigs and ducks marketed to Phnom Penh. However, most of livestock surplus is sold to the local markets and consumed in the district. Crops are transported to the markets mainly by motorcycle and bicycle.

1.4.3 Agricultural Credit

Most of agricultural credit have been provided by local traders acting as money lenders with high interest rates due to absence of institutional credit systems in Cambodia. NGOs like GRET, UNICEF, ACLEDA, provides credit to farmers. In particular, GRET, a French NGO, covers the provinces of Kandal, Kompong Speu, Prey Veng by establishing village banks since 1991.

In the Study Area, GRET has provided rural credit for 615 borrowers, corresponding to only 3% of the total district households. Average loan size is set at 35 US\$ per borrower. Borrowing or lending money between relatives and neighbors still prevail in Ksach Kandal. According to the Rural Socio-economic Survey, 615 borrowers requested short-term credits, with 4% interest rate per month and 5 to 10 months' repayment period. The maximum amount that can be borrowed is 150,000 Riels at one time. Before providing credit, GRET conducted a survey on the solidarity of the village people through training introducing GRET's credit system. One aspect of the training is on information of borrower's duty. After training, borrowers are required to form into groups of five (5) households headed by one chief. This group forms a guarantee system relying on a collective liability under the leadership of one chief. Repayment is on a monthly basis and in cash.

1.5 Agricultural Infrastructures

1.5.1 Irrigation and Drainage Facilities

(1) Colmatage Canals

There exist eight (8) colmatage canals in the Study Area. Two (2) are in Prek Tamerk Commune and six (6) canals in the Puk Reusei Commune. Of the eight (8), two (2) canals in Tamao and Kong Van canals in Puk Reusei Commune are relatively larger in scale with height and bottom of about 10 m and 60 m, respectively, at the entrance of Mekong. Flood water flows not only from these canals but also to some lower part of the rural road along the Mekong and on the bridges along the Phras Konlong road through Srey Santhel district in Kampong

Cham. It is generally difficult to protect flood intrusion for colmatage farming area by each canal (see Figure 1.21).

According to the inventory survey, service area of the canal is estimated at 104 ha for upland crops, 84 ha for wet season rice and 384 ha for recession paddy. The average width and length of the canals are about 8 m and 1.5 km, respectively, except for Kong Van and Tamao canals. Especially, the Slat colmatage canal has the larger service area for dry season rice cropping. Farmers request the construction of intake gate at the entrance of the Phtea lake for further control of water flow. Generally, depth of canal is shallow and side slope is eroded due to intensive rainfall and flood water flow. Dredging and repair of canal and side roads are required (see Table 1.19).

(2) Reservoirs

There exist 37 reservoirs in the Study Area (see Figure 1.21). According to the topographic condition, type of reservoir is divided into semi-closed type and closed-type (see Figure 1.22). The semi-closed type forms depression area with a not so enclosed dike. Upstream of reservoir area is used for recession cropping while receding flood water. Stored water is used for irrigation at downstream farm land. The number of this type is counted at 12 or 32% of total. Almost all are located at more than EL 9.0 m along the Mekong. Full surface water area and its stored water are estimated at 116 ha and 0.8 MCM, respectively. On the other hand, the closed-type means a depression area is enclosed by dike and stored water is used as well as in the semi-closed type. Its number is 25 or 68%. These are located at less than EL 7.0 m. The top of dike is inundated during the flood season. Full surface water area and its stored water are estimated at 530 ha and 4.7 MCM, respectively.

Irrigation area of the reservoirs is assumed at 756 ha for dry season and 114 ha for wet season in the Study Area. Average irrigation area per family in the dry season is about 0.20 ha (see Tables 1.20 and 1.21). Two reservoirs of Som Sey in Sanlung Commune and Ta Nom in Vihearsour Commune are also used as lotus pond. Intake concrete facilities are found at Ta Non reservoir in Vihearsour Commune and Promokal reservoir in Puk Reusei Commune. These intakes were constructed by the beneficiaries. However, these facilities are not operational at present due to deterioration of intake gate. Almost all the width of dike is narrow and its surface is bumpy. About 80% are covered by bush making it difficult for oxcarts to cross. Mean height of dikes is from 1.5 m to 2.0 m. Side slopes are eroded. Farmers make small ditches inside the dike to take supplementary irrigation water at 15 m intervals. However, there are no water control facilities, as sluice gates. The stored waters in the reservoirs are estimated to be about 5.5 MCM. However, almost all the water flows out within a month (see Table 1.22). To maintain the dikes, a manager is selected by beneficiaries by each reservoir. Due to financial difficulty, however, maintenance works are not undertaken at present. Only the San Dan reservoir in Vihearsour Commune is maintained by repairing the slopes, expanding the crest of dikes and clearing the bush.

(3) Canals

Considering the conditions of water sources and purpose of irrigation, canals in the Study Area are divided into four (4) types as follows. Types 1 to 3 are small in scale that farmers can well

maintain. On the contrary, type-4 can not be maintained by farmers because it is large in scale and sedimentation has been developed by eroded side slopes.

Type-1: Purpose of this canal is to take water from the Mekong River using small pumps for land preparation of paddy and upland crops from the beginning of June. Average width and depth are about 0.5 m and 0.3 m, respectively.

Type-2: This type is used to convey water from reservoir to downstream farmland for dry season recession paddy. Canal dimension is the almost same as type-1.

Type-3: This type is used to introduce from the Phtea lake or swamps to the upstream farmland by gravity or pump for supplementary water of dry season recession paddy. Canal depth becomes deeper and deeper toward the upstream land. This type is found at the right bank area of the Phtea lake in Puk Reusei commune. Mean length is about 500 m and the canal is rectangular with average depth of 1.0 m. and width of 0.5 m.

Type-4: This type is the Pol Pot canals in Vihearsour Commune along the Phras Konlong road connecting from the Boeng Sam Bour near the Tonle Toch. In the Pol Pot regime, a pumping station was constructed to supply water. However, the facility was destroyed. All canals are deteriorated and not useful at present (see Table 1.23).

1.5.2 Farm Road

Farm Road is used to transport agricultural materials and products and firewood. The road condition is very bad due to severe flooding. Almost all the roads are inundated. In the beginning of the dry season, roads become muddy and wooden wheel of oxcart damages the surface of roads. This makes roads difficult for bicycles and oxcarts. Farmers do not undertake maintenance of roads. Considering the topographic map (1:10,000) and site investigation, the length of farm road by each commune is summarized in Table 1.24. The highest density of road is 1.25 km/km² at Puk Reusei Commune. There are no farm roads in the Prek Ampil Commune.

1.5.3 Operation and Maintenance of Facilities

Operation and maintenance (O&M) of the above mentioned facilities is supposed to be conducted under the organization as shown in Figure 1.23. Present condition of each organization is summarized below.

Under the Director, one (1) Deputy Director and three (3) Irrigation & Drainage staff in the District Agricultural Office is responsible for O&M of the facilities, such as reservoirs, colmatage canals and farm roads. However, due to lack of office equipment, vehicle, shortage of staff and working budget, etc., the district office can not undertake O&M work.

There are no farmers' organizations for O&M in the Study Area. The chief of commune has the responsibility to organize farmers for O&M. Farmers themselves have to repair the facilities. Due to lack of funds and difficulty to access the facilities, however, maintenance is not properly undertaken at present. Maintenance works to be undertaken by farmers are summarized below.

Irrigation Canal: Bush clearing, digging or dredging and reshaping of side slopes of canal and

proper water control

Reservoir: Bush clearing, expanding or leveling and reshaping of side slope of dike, digging outlet ditch and proper water control

Farm Road: Bush clearing, leveling and reshaping of side slope of road and digging of side canal

Generally, small scale facilities are maintained properly due to easier handling maintenance. Regarding the reservoirs, managers selected by the beneficiaries prepares the plan to repair dike or clearing bush on the dike. Usually these maintenance activities are carried out once a year during agricultural off-season in May. Before cropping recession paddy, farmers cut the dike to make many earth outlets ditches to take supplementary irrigation water from the reservoir. Due to absence of water control facility in the ditches, unnecessary water flows out from the reservoirs causing the reservoirs to become empty within a month.

1.6 Rural Sociology

Rural people in the Study Area think that water for farming is the life line. Hence, they depend on the water of the Phtea lake, surrounding depressions and artificial reservoirs. Though the people are confronted with problems, security of the Study Area is well maintained.

Villages in the Study Area exist on the left bank of the Mekong (300 m wide belt in the same pattern), on high places along the Phras Konlong road and along the Boeng Kagnchap Tbong road. Anlong is the last village along the Phras Konlong road until reaching Vihearsour commune. Sources of livelihood are farming and fishing.

Public institutions undertake rural development in terms by providing required personnel. However, financial difficulties are being experienced in the carrying out of development projects. There are no farmers' organizations in the Study Area. VDCs were formed at all the villages in Prek Tamark commune through a top-bottom procedure. Sometimes a monk plays the core role in a village development. Several NGOs are assisting the rural people in road construction, health, education and fish raising.

Literacy rate in the Study Area is as low as 72.5% over 15 years old. Literacy rate for men is 86.7% and women 58.7%. This is considered as constrain in village development. Net schooling rate of children among 6 and 11 years old is 63.1% at primary school. Many children drop out from school during their study. Although women in the Study Area contribute significantly to farming activity and society, their social status is still low. Social infrastructures are yet to be improved.

1.6.1 Rural Socio-economic Survey

A Rural Socio-economic Survey was done by interviewing 500 households to grasp the present condition of the Study Area. The figure, 500, is about 10% of the total households of 4,992 in the Study Area. The number of the interviewees in each commune was decided according to the size of the communes included in the Study Area as follows:

Prek Tamerk	100
Puk Reusei	182
Sanlung	25
Vihearsour	175
Prek Ampil	18
Total	500

By chance, 22 fishermen were included in the Survey. The rest, 478 were farmers. In this survey, interviewees whose fishing income exceeds farming income were considered as fisherman. Questions covered 64 items of various fields on rural society, agricultural economy, and agriculture.

There are 4,992 households in the Study Area. The Survey shows that 78.6% (393/500) of households were nuclear families. Children 15 years old and under constitute approximately 40% of the whole population. The teen-agers are the most numerous. The number of children under 10 is decreasing. The thirties are less than the forties and the twenties, revealing that they were affected most by wars in the past (see Figure 1.24).

The most serious problem considered by the rural people is flooding. This is followed by poverty and poor transport. Other problems considered were diseases, drinking water, lacking of hospitals and schools, in that order. Specially identified issues are irrigation system, picked up by 132 farmers as serious problem, technical guidance on pig raising (9 farmers) and fish raising (1), animal draft man (2), and pest (2). Since a big flood occurred in the previous year, it is thus reflected in the response to the question on problems in the villages.

Farmers listed the provision of irrigation facilities as the first priority for development. This is followed by flood protection, farm roads, credit service, post harvest facilities, drinking water supply, electricity and hospital, and school, in that order.

1.6.2 Public Institutions for Rural Development

Public institutions for agricultural and rural development in the Study Area are the relevant offices, such as, Agriculture, Rural Development, Public Works, Women's Affairs, Health and Education under the district governmental office. However, all the offices are financial incapable to promote development programs limiting work activities. The offices rely on outside assistance.

The District Development Committee (DDC) was formed in Ksach Kandal. It is chaired by the governor with its members composed of the directors of Rural Development, Agriculture, Finance, Health, Transport, Religion, Women, and Police. A meeting is supposed to be held when a development plan is formulated.

The Commune Development Committee (CDC) was organized at the five communes. The committee is chaired by the commune chief. It involves two deputy chiefs and all village chiefs belonging to the commune as committee members. Some of CDC holds regular meeting. However, the others never held meetings because of the absence of development plans.

The Village Development Committee (VDCs) was organized in Prek Tamerk commune in

March 1995 under the guidance of the commune chief. The number of committee members is from 10 to 12. All the members including chairman were nominated by the commune chief against the regulation that all the committee members should be elected among the villagers through a democratic procedure. Furthermore, women were not included in those VDCs. In organizing a VDC, there is a basic idea that village chief should not be included as member because his duty as village chief is to provide security in the village and to keep records on demographic statistics.

However, some of the VDCs has been working well for the people. For example, the VDC in Svay Att Leu village introduced new rice varieties to the village, rehabilitated small canal, and village road. The VDC in Anlung village rehabilitated the dikes of the Pro Pagn reservoir and the Ta Tum reservoir through WFP. It also constructed two gates at the Phras Konlong road and proposed a plan for rehabilitation of the canal to the district office.

On the other hand, there is a VDC that even chairman and his deputy do not know that they are the committee members. The active VDCs may function as promoting development plan.

1.6.3 Farmers' Organizations

There are no farmers' organizations in the Study Area. According to the Rural Socio-economic Survey, the farmers did not belong to any organizations or group. However, as related organizations, rice banks and managers of reservoirs exist though the organizations' unity is very loose.

There are two rice banks in the Study Area, one of which is located in Boeng Kagnchap Tbong village and another in Knong village. Both were established in December 1995 under the guidance of the Ministry of Rural Development, in which rice was provided by the WFP and one small storehouse to stock rice was built in the village.

According to the information on rice bank in Boeng Kagnchap Tbong village, three (3) persons were selected as chairman, assistant and guard. The annual interest rate is 20%, and approximately one hundred farmers borrowed rice from the bank since December 1995. The bank system is acceptable to the poor people because it is easier to borrow. However, the return rate is so low that 22 tons of rice of initial stock was reduced to 10 tons in June 1997.

On the reservoir, after a manager is nominated or selected, he organizes farmers for rehabilitation works. According to the managers, beneficiaries themselves usually work to repair their dike and gate. However, there was an instance where the manager repaired the facilities at his expense to get fishing right in the reservoir. There were no collection systems of water charge. A manager is usually selected through discussions among the beneficiaries of reservoir. Management is however, very loose.

According to the Rural Socio-economic Survey, all farmers are willing to join agricultural cooperative and water users' association. Farmers expect to receive some services from the cooperatives with supply of agricultural materials, market of farm products, and credit. It is noted that 489 farmers are willing to pay water charge in the future. However, the rest, eleven (11) of them are not willing because the seven (7) farmers have enough water in their fields, while the four (4) are too poor to pay. Considering the Survey, acceptable amount of annual

water charge by farm household is estimated at 13,000 Riels on the average during the wet season and 35,000 Riels during the dry season, for a total amount of 48,000 Riels.

1.6.4 Non Government Organizations (NGOs)

There are several NGOs working in the Study Area, however not in agriculture related activities. Though financial source is not clear, one project is carried out. It has reconstructed Phras Konlong road between Knong and Viheresour, is rehabilitating two bridges, and constructing five new buildings at Knong primary school and Viheresour Cheung primary school.

SHARE (Services for the Health in Asian and African Regions) has been working on health related activities in Ksach Kandal district since 1993. It has been providing health workers training, rehabilitating commune health centers, constructing new building for tuberculosis in the district hospital and disseminating toilet facilities through credit.

SAO (Southeast Asian Outreach) has been assisting farmers in fish culture in Kandal province as a SCALE project. The contents of the project in the Study Area are the excavation of 13 fish ponds for 19 farmers in the villages of Sanlung, Vihearsour Cheung, Vihearsour Tbung, and Prey Chas, using 'Food for Work' project of WFP, and providing fingerlings to the farmers. SAOs budget is US\$ 596,000 in 1996 and US\$ 351,000 in 1995.

GRET (Group de Recherche et D'echanges Technologiques) has been providing rural credit and digging wells for drinking water supply in Ksach Kandal district.

JSRC (Japan Sotoshu Relief Committee) constructed a building at Puk Reusei Krom primary school and provided 500 picture books for a resource center in Ksach Kandal.

Credit Association donated a school building and CIDA (Canada International Development Agency) has constructed another school building at Vihearsour Cheung primary school, though both of them use ODA fund. CAPE (Cambodian Assistance to Primary Education) has been assisting in educational training in the same school.

1.6.5 Women in Rural Society

The Rural Socio-economic Survey shows that 51.0% of total population is women. According to the office of Women's Affairs, as another information, there are 3,994 female headed households among 18,994 of total households in Ksach Kandal district (21.1%). According to the Survey, about 8.2% of the total households (41/500) are female headed households. Generally, female headed households often have more difficulty in living than male headed household.

According to the Survey, women work 12 hours and 6 minutes in a day on the average (farming for 5 hours, housekeeping for 3 hrs. 45 min., child care for 1 hr. 41 min., cooking for 1 hr. 8 min., animal care for 57 min., washing for 55 min., and water fetching for 32 min.). Lotus and grass mat weaving are also one of women's work.

Though wife and women work hard, social matters are in the hands of husband, as attending meetings and making a decision on social issues. Women have less opportunity to speak in

public. Nevertheless they do not complain about it. Furthermore, women are less educated and more illiterate than men, adding to women's disadvantage in the society.

During the dry season when farming activities are at a stand still, many men and husbands go to Phnom Penh to earn income. While husband is absent at home, wife and women take care of all family work and activities.

There is only one staff in the office for women's affairs in the district, who introduced women credit for 51 families in Knong village and 43 families in Anlong village with fund allocation from UNICEF. The interest rate is 3% per month. The lending amount is from 100,000 Riels to 150,000 Riels payable within 10 months. The amount borrowed is usually for buying weaving machine for grass mat, planting vegetables, opening small shop, etc. The office pointed out the presence of many out-of-school children in female headed families, the presence of too many children, and the absence of professionalism in the tackling women's problems. There is a need to set up of women's development center to provide training on professional skills, as sewing, dress making, hair dressing, etc.

1.6.6 Social Infrastructure

(1) Communication

Since there are no telephone lines nor even a post office available in the Study Area, direct contact is the surest way of communication.

Considering the Rural Socio-economic Survey, rural people receive outside information through radio and TV, and through word of mouth neighbors. Newspapers and magazines are not common. Only four (4) people read a newspaper and two (2) read a magazine as source of news.

Transportation facility is car or motorbike. Minibuses and moto-taxis are also available for villagers.

(2) Hospitals

One (1) district hospital, five (5) commune health centers, and two (2) private clinics exist in the Study Area. The district hospital has 17 rooms and 25 beds at present. A new building is under construction for tuberculosis, with four (4) rooms and 40 beds under grass-root grant aid of Japan by SHARE (see Table 1.25).

A commune health center has two governmental staffs, one primary nurse and one midwife, and one to two trained staffs and 2 to 3 health educators. Private clinics are operated by doctors or health workers of government.

The health center at Puk Reusei Commune has been rehabilitated. For Vihearsourand Sanlung and Prek Ampil, the government and SHARE, respectively, will provide assistance in 1997. SHARE has been assisting the health sector at Ksach Kandal district.

The commune health center is the most important place for rural people, providing PHC, vaccination, hygiene education, etc.

Medical treatment and medicines are free for villagers in the district hospital. However, health centers recently try to collect service fees. Medicines are provided by WHO and UNICEF according to the number of patients at each hospital and health center.

(3) Schools

There exist two kindergartens, six primary schools, and two secondary schools in the Study Area (see Table 1.26). In these schools, there are 218 children in the kindergartens, 4,868 pupils in the primary schools, and 973 students in the secondary schools. In Ksach Kandaï district, there is a high school, though it is located outside the Study Area.

Almost all the primary schools lack classrooms except the Prei Chas primary school. Schools are constrained to conduct two class shifts per day. Two primary schools in Knong and Puk Reusei Leu borrow rooms from the secondary schools. However, Knong primary school is now constructing five (5) buildings under the Hun Sen Project. Two buildings are under construction at vihasour Cheung primary school with assistance from Credit Association and CIDA. Many school buildings are dilapidated, and rehabilitation or reconstruction is needed. Furthermore, classes are overcrowded as 48 pupils are required per class in the primary school (see Table 1.26).

According to the Rural Socio-economic Survey, the number of children among 6 and 11 years old are 461. About 566 are studying in primary school, showing that the gross schooling rate is 122.8% in the primary school. It is because 275 of those attending primary school are over their schooling age (48.6% of pupils are over age), so the net schooling rate is 63.1% in primary school. The net schooling rate of secondary school is as low as 23.8%.

Classes in primary schools are reduced according to progress of grades. Hence, the 40 class in the first grade comes down to only four (4) classes in the 6th grade (see Table 1.26). According to a school master, dropout rate is 9% every year. Considering the Survey, there are a total of 996 dropouts from primary school throughout all ages among 3,112 pupils. Findings also reveal that about 541 persons have never attended school. Many of them were affected by the war.

The Survey shows that literacy rate over 15 years old is 72.5% in the Study Area, of which men's rate is 86.4% and women 58.7%. The ratio of girls is 45% in kindergartens, 44% in primary schools, and 31% in secondary schools, revealing that the higher the grade the number of girls also diminishes.

(4) Cooking Fuel

The Rural Socio-economic Survey shows that 100% of household use firewood as cooking fuel. Only one household uses charcoal together with firewood. Source of firewood is generally the reservoirs where natural bushes still remain. Some villagers collect it at homestead, or as wood chips and wood peel at a timber factory over the Mekong river.

Villagers in the Study Area have difficulties in collecting firewood (see Table 1.27). They have to transport firewood by cart or bicycle at a distance of 1 km or even 10 km away from their houses. The quantities of firewood they use differ largely from 0.064 m³ to 2.503 m³ per family

per month depending on the family size and home activities such as mat grass dyeing and pig raising. Children collect mainly ujas (*Mimosa pigra*) which is poor in quality, but grows extensively anywhere and is not heavy.

According to the interview survey, the average firewood consumption per family per month is 0.797 m³, calculated from 20 samples (see Table 1.27). The total firewood consumption in the Study Area per annum is estimated at 47,743 m³.

Firewood is used mostly for mat grass dyeing, a popular household industry in the area. Cooking stoves in the houses consume so much firewood. If improved cooking stove is installed, a great deal of firewood will be saved. Firewood is also used for making brick.

(5) Temples

People in the Study Area are all Buddhists. There are seven temples in the Study Area, Wat Sova Vattei in Prek Tamerk village, Wat Pe Chey Rang Sei in Agn Cheng Leu village, Wat Enda Ly Bo in Puk Reusei Leu, Wat Tro Pang Brey in Thmei village, Wat Prey Lak Mchas in Prei Chas village, Wat Vihearsour in Vihearsour Cheung village, and Wat Ta Tul Rattanaram in Tatul. There is one temple in three villages on the average. A primary school is attached to a Wat Pe Chey Rang Sei.

Temple is the center of people's mental life. Villagers enjoy ceremonies or festivals held in a temple, such as Mak Bochea in February, Khmer New Year in April, Pik Sak Bochea in May, Chol Vasa in July, Phehom Ben in September, Chegn Vasa in October, and Kathen in October and November. On these occasions, they visit temple with lunch box. Foods are given to the monks and are shared among the people. Temple often provides people a place for gathering.

A temple construction committee is formed at each temple. After the Pol Pot regime, temples were the first to be reconstructed in the villages. Since funds for construction are based on donations, it is often suspended due to the lack of fund. The committee also works for school buildings, village road rehabilitation, and/or bridge reconstruction. As monks are very much respected by villagers, they often become leader of village development activities.

1.7 Rural Infrastructures

1.7.1 Rural Road

Considering the reconnaissance and interview surveys with the district office, road in the Phtea lake area is classified into three types, as district road, village road and farm road. District and village roads are considered as the basic infrastructure for rural people. Inventory of roads by commune is shown as Table 1.27.

(1) District Road

Two district roads exist in the area. One road (6.8 km) is located along the natural levee of Mekong river, linking the communes of Prek Tamerk, Puk Reusei and Prek Ampil. The other one (Phras Konlong road) is the only road connecting Prek Tamerk and Vihearsour and Sanlung communes located in the southeast of the Study Area with a total length of 12.0 km.

The width of roads is around 6.0 to 7.0 m. The road conditions are poor, with no pavement, that become muddy in the flooding season. Bridges are provided along the road system (see Table 1.28).

Although the roads are supposed to be maintained by the district office, maintenance work is generally not active due to insufficient amount of working budget. However, some sections of the roads are being improved at present. The sections between Prek Tamerk and Viherasour, within Prek Tamerk commune are planned to be completed before flooding season in 1997. According to the interview survey, improvement plan between Prek Tamerk and Viherasour is as follows.

- Total length -----	L=12 km (including 6 culverts, D=0.8 m)	\$90,000
- Bridge -----	new construction (L=15 m, B=4.5 m), rehabilitation (one site)	\$58,000

According to the Rural Socio-economic Survey, the present road system is recognized as one of priority facility to be improved for rural people.

(2) Village Road

Village road is regarded as important by rural people. Present road density of the village road is estimated to be between 13.4 to 29.2 km/km² (the average is 20.8 km/km² for the whole Study Area). Road condition is very poor, with no pavement, with small width from 1.0 to 3.0 m. The density of major village road is from 6.9 to 12.5 km/km². That of Puk Reusei commune is the lowest. The Rural Socio-economic Survey shows that rural people listed the improvement of village roads as high priority requirement as well as the district roads.

1.7.2 Rural Water Supply and Water Quality

(1) Rural Water Supply

Source of drinking water supply is divided into two, Mekong river along Prek Tamerk, Puk Reusei and Prek Ampil communes, and tube-well in the Vihearsour and Sanlung communes (see Tables 1.29 and 1.30).

The present condition of each source and its covered area is as follows.

- Area close to the Mekong river, Prek Tamerk, Puk Reusei and Prek Ampil communes

In the 1980's, tube-well had been provided by the Ministry of Health (MOH), UNICEF and NGOs. However, it is not presently used for drinking due to water quality problem. Rural people in the area rely on the Mekong river water. In the Prek Tamerk and Puk Reusei communes, simple drinking water supply system consisted of lifting pump at the waterside of the Mekong river, storage tank and gravity pipeline. House tap with meter has been provided privately. Users of the system pay water charge of 1,000 Riel/m³. Water supply service car under the same system is also used for areas far from the system, of which water charge is about 1,500 Riel/m³. The present system has no treatment facility. Per capita water consumption is assumed at 15 to 30ℓ/day.

- Far area of the Mekong river, Vihearsour, Sanlung communes

Most of the households have tube-well as source of drinking water. Water supply system linked with tube-well and pipeline has not been constructed. However, one unit of water supply service car has been provided in the area, of which water charge is 2,000 Riel/m³. Water quality of tube-well is safe for drinking. Well is drilled by private drilling workers in the area, for 80-120US\$ per 30 m. Per capita water consumption is almost the same as in the areas along the Mekong river.

Constraints of rural water supply are summarized as follows.

- Water quality of tube-well in the area along the Mekong river

Water quality from tube-well is not safe for drinking due to high concentration of mineral salts and iron, which give an unpleasant taste. Tube-well system should be developed based on a survey related to potentiality of water quantity and quality.

- Maintenance of tube-well

As shown below, tube-well constructed by MOH and UNICEF is counted at 65, about 100 users per well. The number of users per well is over that of the short term target of 200 persons/well programmed by the Department of Rural Water Supply (DRWS), MRD. However, abandoned wells are counted at 48 (78 users/well) at present due to unsuitable water quality, lack of maintenance fund and personnel. DRWS has begun the rehabilitation work of hand pump from viewpoint of importance of maintenance work. Water quality test should be conducted simultaneously with the rehabilitation work.

(2) Water Quality Survey

Water quality survey was conducted for wells, lakes and river waters in the Study Area to assess their suitability for drinking, irrigation and fish production purposes. Well water was sampled from wells in the villages along the Mekong river and Vihearsour village. Water in the lake was sampled at three locations, the upper, middle and lower end of the Phtea lake. River water was sampled from ferry boat at the middle of Mekong river (see Figure 1.25). According to the survey, water in the tube wells was found to contain 0.03-0.05% of NaCl.

The results of the simplified in-situ test and laboratory test results of the samples are shown in Tables 1.31 and 1.32. The values of the parameters such as pH, COD, SS, Ec, and DO suggest that water in the river and lake poses no hazard for normal paddy growth. Derived parameters such as TDS (Total Dissolved Solids) and SAR (Sodium Adsorption Ratio) also show that water in the river and lake will not affect soil structure and irrigation of upland crops, considering the soil, climate and the extent of the periodic flood in the Study Area.

Test for *C. Bacillus* has shown that most of the water in the tube well and all open waters in the Study Area were infested with bacteria. Water from these sources can be made safer for drinking by boiling.

1.7.3 Rural Living Infrastructures

Besides the rural water supply and roads, sanitary facility and electricity will be required as other basic living infrastructure.

(1) Sanitary Facility

According to the interview survey with district hospital, there are no sanitary improvement plans/projects by public agencies at present. SHARE provides rural people with credit system for construction of foundations of toilet, US\$80 per one unit, at no interest rate. As a result, three (3) toilets in the Prek Tamerk and 30 in Puk Reusei, including eight (8) for elementary schools were recently constructed.

(2) Electricity

There is no electric supply system by public agencies in the area. Only small scale private electric supply facilities are provided for some household groups, which are operated at 5,000 Riel/month for a lamp and 10,000 Riel/month for a television. The Rural Socio-economic Survey shows that 22 of the households use car batteries as source of electricity for lamps.

1.8 Fisheries

1.8.1 Fishing Ground and Fish Capture

(1) Fishing Ground

The fishing area in the Study Area covers the Phtea lake, Boeng Krapeu and their vicinity that comprise of lowlands capable of retaining water after flooding period. The area of the Boengsi vicinity at the water level of EL. 5.0 m and below is about 500 ha. Together with the area of 600 ha outside the Boengsi vicinity, the total area at EL. 5.0 m and below is about 1,100 ha or about 18% of the Study Area (6,130 ha). At the flood height of EL. 9.0 m during the month of September, almost 90% of the Study Area are submerged.

At the water level of EL. 4.0 m, total area of the Phtea lake is about 312 ha. Together with its outlet in the south of about 120 ha and Boeng Krapeu (17 ha), it assumes a great role in fishing during the dry season. However, at the late dry season when the water surface is at 3.4 m (June 19, 1997), about 50% of the water surface area of the Phtea lake remained at EL. 4.0 m of water level.

The mean water depth of the Phtea lake and its outlet when the water level is at EL. 4.0 m, is about 0.5 m. Therefore, with surface area of 312 ha of the Phtea lake, together with its outlet of 120 ha, retained water is estimated at about 21,600,000 cu.m. There are no previous limnological and/or fish population studies of the Phtea lake. Preliminary data from in-situ measurement during the field survey shows that water quality (pH 7.5 and DO 8.6) in the Phtea lake and its outlet are acceptable for fishes.

Fishing ground in this area is varied, depending on hydrological seasons. During the rainy season, most of the area is flooded. Consequently, fishing ground enlarges 9 times of the dry season. After flood receded, fishing is concentrated in areas below EL. 5.0 m for at least six (6) more months until the water availability is only at the Phtea lake, its outlet, Boeng Krapeu and other few swamps.

During the dry season the fishing ground is confined mainly at the Phtea lake and its outlet in the

south, Boeng Krapeu in the north and other few small swamps. The swamps do not contribute significant fishing activities as the Phtea lake and its vicinity.

It should be noted that part of the Study Area and part of the Fishing Lot No. 17 of Kandal Province overlap. The total Fishing Lot area is 8,828 ha, of which about 1,100 ha or 18% belong to the Study Area (see Figure 1.26).

(2) Fish Catch

Fishing operation in the Lot No. 17 has been arranged in eight (8) different fishing points of which three (3) points are in the Study Area and being operated by the licensee himself. They are in the Phtea lake, its outlet and Boeng Krapeu. The rest of the fishing point have been subleased to other fishermen (see Figure 1.27).

Apart from large scale fishing in the Lot, there are medium and small scale fishing being operated in the Study Area. From field observation in June 1997, a number of fishermen operating in the area are found.

From the 67 fisherman households in the Study Area, it is found that the most frequently used fishing gears are the gill net (79%), bamboo trap (49%), hook and line (27%) and seine net (7.5%). Many of them indicated sing more than one type of gears.

Annual fish yield from the Lot No. 17 during the last two years (1995-1996) was reported to be about 157 ton. Considering earlier estimated ratio of production from large scale fishing and family fishing of 7: 2.5, the family fish production may be estimated to be about 41 ton/year. From this point of view, the yield from this Lot may vary from 190 to 200 ton/year for the last two years. This indicates that the yield per unit area (ha) of surface water is about 23 kg/ha for five (5) months which are unusually low.

To get an idea of fish yield from the Lot, another point of view must therefore be considered. Assuming that average fish price is at 0.1016 million Riels/ton and the sublease fee and investment cost for fishing gear is 65,000,000 Riels, (Section 2.8.3 describes fishing costs), the sub-licensee(s) have to catch fishes of not less than 639.8 ton (or 318.9 ton/year) to cover the investment cost of 65,000,000 Riels. This does not yet include the costs of labor, transportation, and marketing.

Furthermore, the fish caught by the licensee himself has not yet been taken into account. If the analysis above shows something near to the reality, the report of fish production in the Burden Book of DOFi (157 ton/year) should be considered as under declared. The figure of production from the Lot of 318.9 ton/year (4-5 months) will therefore be used as a reference throughout this study.

Result of interviews also reveals that the average household size is compose of 5-7 members. Dominant age group is found to be 10 - 20 years old. More than 50% are schooled, but mainly not beyond primary level. Labors are mostly used for both fishing and farming.

Aquaculture is not practiced in the Area. However, during the field reconnaissance it was observed that temporary stocking of live fish in pens and cages when there is surplus catch is

commonly practice. Few cases of stocking of sand goby in the Phtea lake are observed.

Result of the survey also reveals those 70% of fishermen are interested in aquaculture. Constraints indicated are the lacks of capital, technical skill, water availability throughout the growing season and, last but not least, satisfied results from the neighbors who ever tried.

1.8.2 Fishery Production and Utility

When referring to fish production, there are few specific terms to be clarified for their definitions. The term "production" means an increment of biomass of fish in particular environment while "productivity" means the rate of biomass increment on space and time. On the contrary, the catch by fishermen is equivalent to "yield" and "standing crop" means an existing of fish biomass at specific time. In the section below, the biomass production and yield of fish in the Phtea lake is elaborated.

According to the field observation data in June 19, 1997, the standing crop of fishes in the Phtea lake can be estimated from sampling by encircling purse seine of 100 m length. This encircling purse seine, when surrounded by the water area, covers an area of 795 sq. m.

Each haul yields 50-60 kg of fishes. Thus, the standing crop of this particular date is about 690 kg/ha. However, this figure can not be considered as a standing crop in its real term since the fishes therein is trapped and concentrated from larger area at the end of flood season.

Since the water surface of this particular date is about 50% of the area when the water level is at EL. 4.0 m, and if water surface area of 312 ha as mentioned above is considered, the standing crop would be about 345 kg/ha. This is within the range of most of the swamps in Southeast Asia

Most of the fishes caught are Sheatfish (*Kryptopterus* sp.), Catfish (*Mystus* sp.), Silver Barb (*Puntius* sp.), Smith Barb (*Puntioplites* sp.), Soldier River Barb (*Cyclocheilichthys* sp.) and Glassfish (*Chanda* sp.). Most of the fish lengths are about 10 - 20 cm.

There are three (3) indirect approaches to measure production from a standing water body. The first is by sampling fish standing crop as described above; the second is by comparison with fish production of swamps of the same region; while the third is by using data on morphology and water chemistry of the swamp or in other words known as imorpho-edaphic index (MEI). The MEI formula is:

$$\text{MEI} = \text{conductivity (uMos/cm)} / \text{mean depth (m)}.$$

For a swamp that has reached its maximum level of fish exploitation (catch = production), the relationship of production and MEI is shown below:

$$\text{Production (kg/ha/year)} = 14.3136 \times (\text{MEI})^{0.4681}.$$

The mean depth of the Phtea lake is 0.5 m. and the conductivity in the dry season is 145 uMos/cm. The MEI is thus 290. Considering the above formula, the production of 0.204 ton/ha/year can be achieved. Considering a half year of dry season, the production from the Phtea lake alone would be around 46 ton.

As records from the Lot are always under valued, it is at the moment difficult to determine actual fish production for the study. Estimation based on various assumptions are shown below:

Area of more than 3 month- flood period (EL. 9 m and below)	=	5,330 ha,
Fish production from the Lot No. 17	=	318 ton/year,
or	=	0.036 ton/ha/year,
Plus family fishing 35% of large scale fishing	=	0.049 ton/ha/year,
Plus fishes remained uncaught 30%	=	0.06 ton/ha/year,
Total production from flooded area 5,330 ha	=	320 ton/year.

Therefore, the total fish production inside and outside the Lot from large, medium and small scale fishing, and inclusive of uncaught fishes, may be around 320 ton/year or 640 ton that is equivalent to one leasing period of the Lot.

Considering the results of previous studies on fish grade composition, the ratio of First Grade, Second Grade, and Third Grade is 1:2.2:13.3. The catch of the three grades, first, second and third is estimated at 19.3, 42.7 and 258.3 ton/year, respectively.

Provided the fishes of first and second grade are sold elsewhere and the third grade of 258.3 ton is for local consumption, the net contribution of fish to the local diet of the local population of 26,715 would be about 9.7 kg/person/year. This is equivalent to about 69% of national average, 13-15 kg/person/year. However, it should be noted that these people also catch fish outside the Study Area and/or sometime consume high grade fish.

Fish catch is not only sold as fresh or trash. It is also preserved in various kinds of products for family consumption. However, fish processing for commercial purpose is mostly in the hand of fish wholesalers. They process fishes into fish paste, salt-dried fish, smoked fish and fish sauce. Most of them are in the scale of cottage industry.

No official record is available on how much of the catch in the Study Area is converted into processed products. However, based on the countrywide percentage of fresh fish processed into various kinds of fishery product of about 40%, the processed fish in the Study Area can therefore be estimated to be about 128 ton/year.

1.8.3 Control and Management of Fishery Activities

DOFi is not the only institution involved in the control of fishing activities in the Study Area. Fishing activities are also controlled by the Kandal Provincial Fishery Inspection Unit that is under the authority of Kandal Province. The function of the DOFi is mainly confined to technical guidance. The Provincial Fishery Inspection Unit in turn designates its authority to the Muk Kampul Sub-Unit for the day to day and routine operation in Lot Nos. 12, 13, 16 and 17. The organization chart involving the control and management of fishing activities is shown in Figure 1.28.

Fishery management in the area involves informing people about fishery law, arranging meeting for fishery resources conservation, and operation in the bidding of Fishing Lot and let the

licensee run a show.

During 1996-1997, the standard auction price was 30,000,000 Riels and may remain the same for the coming years. The bidder tendered for 33,400,000 Riels. After winning the bid, he then divided the Lot into eight (8) fishing points. The three (3) were operated by himself while the other five (5) he subleased to other fishermen from whom he received 35,000,000 Riels in cash. The fishing gears that may cost about 30,000,000 Riels or more are the responsibility of the sub-licensee(s). The total cost for the initial investment of the sub-licensee(s) may be around 65,000,000 Riels

Apart from a lot management, visiting of fishery officers from the Inspection Unit has been irregularly conducted. The purposes of the visits are mainly to control illegal fishing, keeping people informed on fishery law and to determine whether the fishing gears of the Lot licensee(s) have been removed at the end of fishing season.

It is not therefore surprising that quite a number of fishermen have been in contact with fishery officer regarding fishery law. As much as 48% of fishermen have indicated that they have been informed by the fishery officers, except in Sanlung.

The people in the Study Area receive knowledge on conservation from mass communication (33%). In Prek Tamerk they also receive information from other source, as from fishing lot licensee (14%). About 42% indicated receiving direct information from meeting arranged by government officers.

On fishery information other than fishery law, fishermen receive mostly information from mass communication, mostly from radio and television, 94% and 78%, respectively. Other information source is the government (13%).

For fish marketing, there is no restriction on landing, fish price and buyers. Most of the fishermen sell their fish catch according to their choice and commitment, mostly to persons/groups where loan has been obtained. The market shares of the middlemen, wholesaler, and others are 39%, 34%, and 19%, respectively.

There is no institutional credit facility available for fishermen in and/or for the Study Area. Most of the fishermen either obtained loan from money lender (63%), often with high interest rate. Payment may be made in cash or fishes. Very few (3%) received loan from relatives and neighbors.

The fishermen interviewed have no experience joining or forming fishermen association of any kind. Most of them operate on an individual basis, for fishing, marketing and obtaining loan.

For external assistance, the SAO (Southeast Asian Outreach) has conducted small scale aquaculture extension in the Study Area since 1994. Pilot project has been set up in Sanlung, Vihearsour and Prey Chas on the cultivation of few species of fishes such as carp, tilapia and common silver barb. Thirteen ponds with an average area of 241 sq. m has been constructed in these communes. The results of production are 2.8 - 3.6 ton/ha/year and considered as satisfactory. Also, a seed production center of eight (8) ha expected to produce fish seed of 4,000,000 fries/year has been completed and now under operation. Nineteen fishermen families

have already turned to aquaculture operation while a number of them have shown interest.

1.8.4 Relation between Farming and Fishing Activities

Farming and fishing activities in the Study Area are normally practiced side by side. Most of the farmers take all possible opportunities to catch fish for consumption and as source of additional income. From the Rural Socio-economic Survey it was revealed that only 13 households out of 500 are full time fishermen. Only very few farmers do not derive any kind of income from fishing.

Results of the survey indicate that 100% of fishermen has other sources of income aside from fishing. Attention should focus here on the degree of intensity of fishing and farming activity. Normally, it proceeds around a hydrological cycle. However, the fishermen and farmer have similar pattern of division of household labor. Some family members are fishing while the other members are engaged in farming.

However, during the flood season when most of the area is under water, farmers undertake fishing activities or are employed in fishing lots. On the contrary, during the dry season when water is scarce, they do other activities, as getting employment elsewhere, make mats, do fishing activities or gather firewood.

Apart from farming and fishing, the people are involved in social activities/functions, such as funeral, ordination, marriage and religious ceremonies.

1.9 Environment

1.9.1 Social Environment

The Study Area is recognized as a typical rural area along the Mekong river. Its social environment will not be changed rapidly as long as hydrological patterns of the river remain unchanged. The life of rural people is based on agricultural production under the annual flood cycle of the river.

Though the O&M activities of the reservoirs are not performed actively besides repair work of bank, communes and villagers can mediate the interest of the beneficiaries. There is no serious disharmony to secure irrigation water between villagers or villages at present.

Paddy cropping is the main agricultural activity in the area. Since most available land is already used for paddy field, land for agricultural development is very limited. Most farmers have been applying pesticide of WHO class Ia, but present degree of agrochemical contamination is not certain.

No.17 Fishing Lot is under a combination of water bodies (including the Phtea lake) and farm land. However, there is no serious conflict between farmers and fishermen.

Villagers collect firewood in the flood forest. Over-cut of branches or vegetation may bring negative impact on fishery resources and social conflict.

Hygiene, medical and drinking water conditions are still at a low level as same as other rural areas. There is scarce case of crucial infectious or endemic disease except the popular parasites.

There are no places of historic and cultural importance to preserve, except the temples in the area. These temples serve as the place for meetings or refuge during serious flood.

1.9.2 Natural Environment

Since ecological and social system in the area is under influence of the Mekong River, it will not change unless a drastic change occurs in the hydrological environment. No critical pollution of water and soil caused by industrialization and urbanization, eutrophication of water bodies is expected.

Most of the trees in the flood forest belong to Lecythydaceae and Combretum. Their seeds and seedling spread easily by flood water and grow rapidly. Since the branches are collected by villagers for firewood, their preservation and management are indispensable for sustainable supply of firewood and conservation of ecosystem in the area.

There exist many kinds of flora and fauna in and around the Phtea lake. A nationwide inventory including invaluable species has been prepared by the DOFo. No valuable specie to be preserved has been found so far.

Some of the reservoirs are actually in the fishing lots and are important habitats of fishes. The rehabilitation of the reservoirs leads to the conservation of fishery resources. However, there is a need for an identification survey of fish habitat for the rehabilitation. Although the Department of Fisheries (DOFi) has conducted a nationwide inventory survey on fish, data in the area is very limited.

There is no data on fragile ecosystem easily affected by environmental change in lake and swamp areas including flood forest.

CHAPTER 2 AGRICULTURE DEVELOPMENT PLAN

2.1 Basic Approach

2.1.1 Development Constraints

The major development constraints are summarized based on the three following aspects.

(1) Physical Aspects

- Untimely and inadequate water sources and deteriorated irrigation facilities limit the development of paddy cropping system. Drying/receding of water source and lack of irrigation system also limits extension of dry season cropping.
- Frequent floods bring severe damage to agricultural and rural infrastructures.
- Although the natural vegetation areas including inundated forest in and around the Phtea lake are considered as area for fish habitat and fishing ground, land use is changing due to high pressure on agricultural land and demand for firewood. Fishing ground tends to deteriorate as vegetation area is disturbed. This may cause decrease in fish production.
- Lack of farm road network and presence of muddy roads in the rainy season makes it difficult for farmers to operate and undertake agricultural activities and to get access to systematic marketing.
- Inadequate public infrastructures result to unstable rural life.

(2) Agricultural and Socio-Economic Aspects

- Crop productivity is low due to insufficient agricultural infrastructures and frequent flooding.
- Agricultural inputs especially supply of certified seeds are limited. As a consequence, paddy farmers are constraint to set aside rice seed from their production. This causes decrease in production due to variety deterioration.
- Insufficient supply of fertilizers and chemicals also cause low level of crop yield and production. However, unbalanced input management may also cause deterioration of fishing ground and natural vegetation.
- Extension services for improved farming techniques are not sufficient. Credit system at reasonable interest rate is not also provided. Due to lack of supporting services, farmers do not direct their farming practices towards intensive and commercial agriculture.
- Agricultural and socio-economic activities in the waterside of swamp and lake disturb the natural ecosystem. Especially, firewood cutting and land reclamation in the inundated forest area without any consideration for environment causes the decrease of waterside fish habitat.

(3) Institutional Aspects

- Farmers' groups for operation and maintenance of the infrastructure facilities are inactive. Most of the facilities are abandoned. Especially, insufficient management of irrigation facilities including the reservoirs limits extension of irrigated land and improvement of crop productivity.

- Lack of funds restricts the construction and rehabilitation of facilities. Lack of experienced technical staff in facility planning, design and implementation are also considered as problems for provision of adequate design standards and implementation specifications.
- Support programs to promote developments of farmer's organization are not provided.

2.1.2 Development Objectives

Reflecting the development objectives of the Master Plan and development needs and constraints of the area, the development objectives for the Study Area are identified as follows.

- To contribute to regional needs by increasing crop production with assurance of self-sufficiency in rice,
- To stabilize rural life through enhancement of agricultural based rural development by providing agricultural and rural infrastructures, and
- To conserve fishery resources for sustainable inland fishery through the rehabilitation of fishing grounds in harmony with farming.

2.1.3 Framework of Development Plan

To achieve the above-mentioned development objectives, the following measures will have to be undertaken.

(1) Infrastructure Measures

- Construction/rehabilitation of multi-purpose reservoir

The main purpose of the reservoirs is to impound flooded water for dry season rice cultivation. The embankments, however, are in bad condition, that makes it difficult to store the water. It should be rehabilitated as multi-purpose reservoir for storage of irrigation water, conservation of inundated forest and fish habitat. Gate structures to control the impounded water shall also be provided.

- Construction/rehabilitation of canal systems

The canal systems are required for irrigation facilities. Existing canals, especially Pol Pot canals, need re-excavation and reshaping. The embankment of canal is also used as road. Culverts shall be provided to be used as road crossings.

- Construction/rehabilitation of farm roads/dikes

Farm road networks do not exist in the area, except for district and village roads located in the high elevation areas. Plot boundary dike is also used as natural farm road. Most of farmers reach their fields only on foot. Transportation of agricultural products remains difficult. Construction or rehabilitation of roads is needed for undertaking of agricultural activities. The roads also serve as flood protection dike and water conservation dike. In the area, it is difficult to protect flood intrusion throughout the flooding season. The purpose of dike is to protect flood water at the beginning stage of flooding to allow harvesting of planted crops.

- Construction of small scale water conservation weir

Natural vegetation areas in the periphery of the Phtea lake are being disturbed by human activities to gain access to cultivable land, firewood, water and fish. Disturbed area can easily be damaged. These areas will dry up unless some remedial actions are taken. Deterioration of fish habitat will directly cause decrease of fish production. Necessary measures, therefore, should be undertaken to conserve the waterside vegetation area for sustainable fishing activities. Construction of facility to keep the waterside swampy as close as the present condition, is one of infrastructure measure. Construction of small scale weir at the outlet of the Phtea lake is an effective measure for this purpose. The structure of weir should be planned based on the extent of recession farming and fishing activity in and around the Phtea lake.

(2) Non-Infrastructure Measures

- Strengthening of agricultural supporting services

Extension services that will encourage farmers to introduce proposed cropping system are required for success of the development project. To improve the present farming practices, productive farming techniques and results of studies on cropping system have to be provided to individual farmers without access to extension services system. Government assistance should be provided for extension works.

Intensive agriculture and inland fishery require the provision of an efficient and systematic credit system. Farmers and fishermen should provide easy access with minimum interest rates.

- Establishment of farmers' organization

Farmers themselves should operate and manage the infrastructure facilities mentioned above. The management of the rehabilitated reservoirs such as control of water flow, woods cutting in the inundated forests and equitable water allocation among farmers are important for successful implementation of the proposed projects. A properly managed reservoir will cause stable and sufficient dry season irrigation water. Although farmers are not generally keen on being organized by outside forces unless they can get direct benefit from organizing, it is imperative that they be organized. As a first step, water users' groups should be organized by reservoir. After organizing the farmers, other organizations like farmers' credit groups, livelihood enhancement groups and women's groups may be developed to support income activities of the farmers.

- Provision of operation and maintenance supporting office

The need for operation and maintenance should be stressed for successful implementation of the proposed development project. The operation and maintenance activities should be supported by related administrative offices. It is, therefore, proposed to develop an operation and maintenance supporting office. The proposed office is not a new political administration but will serve as a technical service center to enable farmers to support their farming cum fishing activities. Expected requirement for the office is the provision of various supporting services such as extension, credit, establishment of farmers' organization and training. The office will be supervised by qualified experts. Facilities and equipment/machine needed for smooth operation in the initial stage should be provided. The office will also need small scale multi-purpose building that farmers could use for various development activities.