PART 1 MASTER PLAN STUDY

CHAPTER 1 INTRODUCTION

1.1 Introduction

1.1.1 Background of the Study

Agriculture sector in Cambodia has been the top earner of national economy, occupying about 45% of the GDP in 1994. Cambodia was a typical rice producing and exporting country with favorable natural conditions for paddy cultivation. The internal war, however, brought conspicuous drop of rice production and labour force.

The Mekong River flooded area covers about 1.0 million ha of land sprawling on the wide-spread plain of alluvial deposits, depressions and backswamps. The area forms the best agricultural productive area in Cambodia due to abundant land and water resources. In the area, traditional agriculture as characterized by colmatage and recession farming, is practiced with annual flooding cycle.

The flooded area is also the most important region for Cambodia's economic reconstruction. It is located near Phnom Penh, the capital of Cambodia which absorbs about 30% of the country's population. However, most of the agricultural infrastructures and rural community were destroyed by the war. Consequently, agricultural productivity is presently stagnant at low level due to lack of agricultural facilities, labour, materials, market and credit system.

Agricultural sector has been recognized as the top priority for rehabilitation and reconstruction in Cambodia. Agricultural and rural development will contribute directly to boost national and rural economic growth, living standard of rural people and stabilization of rural life.

Under such circumstances, the Government of Cambodia has requested "the Agricultural Development Study of the Mekong Flooded Area in Cambodia" to the Government of Japan. In compliance with the request of the Government of Cambodia, the Japanese government conducted a preliminary survey in October 1995, and a Scope of Works (S/W) for the Agricultural Development Study of the Mekong Flooded Area in Cambodia was concluded. Based on the S/W, Japan International Cooperation Agency (JICA) dispatched a study team in April 1996 to perform the study. The Study was divided into two phases and this report presents the study results of the Phase I and II Study.

1.1.2 Objectives and Scope of the Study

The Scope of the Study is summarized as follows:

(1) Objectives of the Study

The objectives of the Study are as follows:

- To make a master plan on agricultural development of the Mekong flooded area in the southern region of Cambodia, and to conduct a feasibility study on the agricultural development plan for the priority project(s) and area(s) selected through the master plan study.
- To carry out technology transfer to the Cambodian counterpart personnel through on-the-job

training in the course of the Study.

(2) Scope and Contents of the Study

1) Study Area

The Study Area covers an area of 1,188,000 ha, in the five provinces of Kratie, Kompong Cham, Prey Veng, Kandal and Takeo in southern region in Cambodia. (According to the S/W, the Study Area was 600,000 ha. As the result of the study, it had been redefined as the flooded area, or 1,188,000 ha.)

2) Contents

- Phase I Study

Master plan study on the Agricultural Development Study for the Mekong Flooded Area was conducted, and priority areas and projects were selected in the course of the study.

- Phase II Study

Agricultural development plans for the selected priority areas were formulated and feasibility study was conducted, considering the outcomes of the Phase I study.

1.2 National Background

1.2.1 Land and Population

(1) Land

Cambodia is bordered by Thailand in the west and by Laos and Thailand in the north, by Viet Nam in the east, by the Gulf of Thailand in the south. Geographically, Cambodia can be divided into two (2) regions, that is, the Mekong river basin and Tonle Sap plains which is the main paddy producing areas of Cambodia, and periphery of the river basin and the mountainous areas on three (3) sides of the country.

The total acreage of the country is 181,035 km^2, consisting of 19 provinces, two (2) municipalities and 172 districts. Some 67% (12.1 million ha) of the country is classified as forested area. The cultivable area is estimated at 21% (3.78 million ha) of the country according to the Landsat survey, however uncleared mines restrict expansion of cultivated area. The cultivated area with paddy is 2.08 million ha in 1995, occupying 91.2% of the total planted area with various crops.

(2) Population

The first and only census of the population of Cambodia was carried out more than 30 years ago in 1962. Estimates of the size and structure of the population which have appeared in government or UN agency publication since that time have been based on projections employing a range of assumptions of birth and mortality rates.

The current population of Cambodia is estimated at 10.5 million, which has been growing at annual average of 2.8% with population density of 51 persons per km^2. Population is divided into 85.4% in rural areas, 7.7% in urban areas and 6.9% in Phnom Penh, respectively, in 1995. It is notable that there is sex imbalance, 52.2% are female and 47.8% male, and high proportion of young generation because of two decades of conflict.

The life expectancy is estimated at 51 years and infant mortality rate is as high as 115 per 1,000 live births. According to the sampling survey conducted in 1993, total illiteracy ratio of above 15 years old is estimated at 37.5%, composing 22.1% for male and 50.5% for female. Population with access to health service and safe drinking water are 53% and 35%, receptively, in 1995.

1.2.2 Socio-Economy

The Cambodian economy is still constrained by the effects of the destruction of social infrastructure, production systems and social services which occurred during Pol Pot regime. Current per capita GDP of 289 US$ is considered as one of the lowest in the world. The Socio-economic Survey of Cambodia prepared by the Ministry of Planning reports that 38% of households or 30% of people are living on income lower than poverty line. Poverty alleviation, therefore, is one of the most important target in the First Socio-economic Development (1996-2000). The GDP growth rate has once depressed in 1994, however, it was restored to 7.6% in 1995.

Balance of trade shows deficit over these years and it has been increasing along with increase of imports.

Agricultural sector is the mainstay of the Cambodian economy, contributing 75% to employed persons, 45% of GDP and exporting. Despite its contribution to the national economy, averaged monthly household income of about 130,000 Riels per family in rural areas is lower than that of urban areas and it is reported that about 90% of household in the rural areas lives on incomes lower than poverty line. The agricultural sector is predominated by subsistence farming, in particular paddy production under rainfed condition. Cambodia produced 2.2 million tons of paddy in 1994, with about 200 thousand ton deficit. Compared to 1994, about 230 thousand of surplus paddy was produced in 1995. Paddy production, however, is still highly dependent on rainfed farming characterized by low yield and low input of fertilizers.

Paddy, main agricultural product of Cambodia, can be characterized as below;

- Cambodia was exporting country of paddy in 1969
- attainment of self-sufficiency of paddy is given the top priority in the First Socio-economic Development
- the staple food, consumption is 253 kg per capita per year of paddy
- contributing 12.8% to GDP and 28.5% to agricultural sector
- occupying 91.2% of the total planted area
- major source of farm income of farm households
- highly dependent on rainfed farming

- yield is classified as the lowest in the Asian countries

The government is now promoting the First Socio-economic Development for 1996-2000 aiming at acceleration of economic growth, poverty alleviation and rehabilitation of production system under the market economy system. All price control was abolished by 1993.

The government recognized the right of land possession and inheritance by amendment of the constitution in 1989.

1.2.3 Agricultural and Rural Development

Being blessed with fertile land and affluent water resources along the Mekong river system, Cambodia has been and still is an agricultural country. It achieved self-sufficiency in 1960's and had been exporting rice and rubber. However, prolonged civil war and social chaos devastated large tract of agricultural land. Agricultural inputs and materials such as seeds, chemicals, farming tools and livestock were lost, and labor population decreased. Fundamental infrastructure was destroyed and left without any rehabilitation, management or development.

The neglected of agricultural development seriously affects not only farmers, but also the refugees who are urgently in need of safety and stable living environment. Improvement of the rural areas by agricultural development is a immediate need for those who lost their living place. Moreover, fostering the development of the rural economy would generate growth in GDP to the whole country and generate productive employment.

The overriding objective is to raise the living standards of all Cambodian people and achieve a fair and peaceful society through accelerating the rate of economic growth. Agricultural development can make a crucial contribution to these goals, although it will require the pursuit of development strategy which manage to combine growth, sustainability, equity and social justice successfully.

Generally speaking, agricultural development is achieved by the extension of agricultural land. However, Cambodia has the peculiar constraints such as insecurity and land mines. Moreover, because of frequent flood and abandoned irrigation facilities without any repairs, agricultural production have been stagnant.

The rehabilitation and development program of agriculture and rural life has to be formulated carefully considering above unique conditions in Cambodia to make a major thrust towards bringing development to the more remote areas and for raising the living standards of all Cambodians.

1.2.4 Food Security and Recent Agricultural Policies

In 1993/94, Cambodia's food balance showed deficit by 183,000 ton of paddy and this deficit was restored in 1995 crop year by producing about 3.2 million ton. The majority (85%) of people in Cambodia live in the rural areas and most of them are engaged in the agricultural sector. Although about 90% of the cultivable lands are under paddy cultivation, many farm households fails to produce sufficient rice even for home consumption and this is resulted in earning off-farm incomes such as fishery, labor etc. Food security, therefore, is considered as

the most important issue in the country.

The basic goals of the agricultural policies in the First Socio-economic Development Plan (1996-2000) are mentioned as below:

- Ensure food security through expansion in the production of paddy, or its availability through the market, and of secondary food crops;
- Contribute to economic growth and to foreign earning through exports; and
- Improve income opportunities for farm households by diversifying crop production.

The First Socio-economic Development Plan also estimates that a 30% increase in paddy production would be needed over next 10 years to maintain country demand. This is equivalent to a 2.7% annual increase, which is almost the same as the overall population growth rate of the country. The major problems to be solved on food security is instability of paddy/cereal production which is seriously affected with annual rainfall and flooding condition causing flood and drought damages on crop production.

CHAPTER 2 THE STUDY AREA

2.1 Natural Conditions

2.1.1 Geology and Meteorology

(1) Geology and Topography

The lower Mekong delta in Cambodia, including the Tonle Sap Lake, was a part of the sea during the initial Alluvial epoch, about 6,000 years ago. As the sea retreated and the depth became shallower, the sediments were deposited at around the granitic and volcanic knolls, especially around Kompong Chhnang where the knolls were the nuclei of sand dune formation. The sediments were from the erosion in the gorges of the upper Mekong which started during the Tertiary Period. The activity of sediment deposition in the lower Mekong delta is still evident today and is aggravated by the heavy clearing of forest around the Tonle Sap Lake, resulting in diminishing lake surface area and depth.

Much of the delta is underlain by the diluvium and alluvium layers, a formation of fine sand, silt and clay deposit. Boring data along Mekong, road improvement and well construction projects have shown that the sand layer (fine to coarse) below clay and silt top layers is about 20-40 m. Below the sand layer is the weathered sandstone and/or mudstone layer.

The central plain, in which the Study Area is located, is surrounded by the Cardamon and Elephant mountain chains-1,000 to 1,800 m- to the west and southwest, the catchment of Tonle Sap Lake to the north and the low 40 to 200 m- and high 400 m-1,000 m- undulating plateau to the northeast. The Study Area is generally below 30 m elevation, gradating in altitude from north and west towards south and east: The edge of the plateau in the north and west is about 30-35 m, the confluence of Mekong and Tonle Sap river 10 m, Takeo 8 m and Svay Rieng 3 m. A large part of the plain is below 10 m in elevation. The plain can also be divided into river banks or levees, the lowland between the levee and the terrace, and the upper terraces.

Geologically, the flooded area consists almost entirely of young and old alluvium soils deposited by the Mekong river. The soils have a high fertility and a wide range of crops can be cultivated. Old alluvium forms generally sand, clay, silt and laterite and contains the aquifers. Land surface is underlain by young alluvium consisted of silt, clay and laterite. In some places, laterite is found in the surface, which makes cultivation difficult. In general, the surface soil is soft and easily becomes muddy with rain water since its infiltration rate is low. For infrastructural planning in these places, therefore, appropriate countermeasures for erosive embankment and soft ground should be considered. Especially, appropriate foundation treatment should be applied to some infrastructure facilities.

(2) Meteorology

The climate of the Study Area, with distinctly marked dry and wet seasons intervened by short periods of transitional instability, is strongly dominated by the tropical monsoons: The wet season, with frequent and heavy rainfall brought by the southwest monsoon, lasts from mid-May

to November; and the dry season, influenced by the northeast monsoon, lasts from December to April.

The Study Area is relatively drier with an average rainfall of about 1,000 mm towards the south and 1,600 mm towards the north. Rainfall occurs sooner in the north and together with the peak shifts southward towards the end of rainy season: The peak in Kratie happens in August/September, Kompong Cham and Phnom Penh in September, Prey Veng in September/October and Takeo in October. Rainfall varies widely from year to year. Typically in June or July, there may be short period of consecutive dry days (10-15 days) which causes farmers to delay cultivation.

Except for rainfall, spatial variation in weather is small. Mean monthly maximum temperature ranges from 30 in December to 34.6 in April, minimum temperature from 21.1 to 25.8 and mean temperature from 25.0 to 29.7. Relative humidity ranges from 67% in March to 84% in September. Monthly evaporation varies from 108.8 mm in September to 227.5 mm in March and sunshine from 173.9 hr in August to 279.7 hr in February (see Appendix C).

2.1.2 River Systems

Mekong river before and after Phnom Penh, Tonle Sap river and Bassac river, all confluencing at Chaktomuk, form the four arms of the distorted "K" shape river system (see Figure 2.1). Mekong river flows southwestward after Kompong Cham, southeast after Phnom Penh and southward after Neak Luong. Tonle Sap river, the outlet for the Tonle Sap Lake, flows southeastward before joining Mekong at Chaktomuk. The Bassac river, starting at Chaktomuk and flowing almost parallel to Mekong within Cambodia, flow directly into the Mekong delta complex in Viet Nam.

The Study Area is drained by the two arms of Mekong (Middle Tonle Thom, about 100 km long, 0.8-7 km wide, 30-50 m deep and Lower Tonle Thom, 95 km long, 0.9-4 km wide), the lower reaches of Tonle Sap river (33 km long, from Prek Kdam to Phnom Penh) and Bassac river (83 km long, 0.4-2.5 km wide). The bed elevation of Mekong river is below Hatien M.S.L. from around Kompong Cham. The main tributaries are Prek Te, Prek Chhlong, Tonle Toch (100 km long & 30-50 m wide), Stung Prek Thnot, Stung Slakou and Stung Takeo. Except for Tonle Toch which diverts some of the flood water of Mekong at Peam Praphnouh (9 km south of Kompong Cham) during rainy season, the other tributaries flow out from relative higher ground and have catchment of their own.

2.1.3 Hydrological Features of River Systems

(1) Water Level of Gauging Stations in the Study Area

Average monthly flood stage at the stations along Mekong, Tonle Sap and Bassac rivers in the Study Area were plotted to delineate the characteristics of flood (see Figure 2.2). Except for Prek Kdam along Tonle Sap river, the water level of all other stations follow similar trend of rise and fall: with that of Kratie being the highest, follows by Kompong Cham, Chrouy Changvar, Chaktomuk and Neak Luong. Generally, water level starts to rise in May, peaks in September and continues to level off until April. From November to April, when water level of Tonle Sap Lake is falling, water level at Chaktomuk appears to be slightly higher than that at Chrouy

Changvar. This could be caused by erroneous datum when considering the geography and hydrology of the two stations. Whatever small difference exits between the two stations could be outstep by the larger datum error. The difference in water level between Prek Kdam and Chaktomuk is generally small. From October to June, when Tonle Sap Lake is emptying the flood water from its catchment and that of reverse flow stored during rainy season, the water level of Prek Kdam is slightly higher than that of Chaktomuk. One other fact of the yearly fluctuation of water level that warrants attention is the double peaks seen in most of the stations. The first peak usually comes in June as a result of snow melting in the Tibetan plateau. This water from melting snow, which brings about higher rising rates of water level, seldom causes water level to cross the threshold flood level. The second peak, resulting mainly from rainfall brought by the southwest monsoon, happens in September and could cause huge area of inundation over a period of 3-6 months.

The table below shows the mean highest monthly values of rising and falling rate, average, maximum and minimum range of fluctuation and threshold water level of colmatage canals around the observation stations in the Study Area.

Average Rising and Falling Rate, Average, Max. & Min. Range, and Threshold Water Level

(Unit: m, m/day)

Station	Rising trend		Falling trend		Range of fluctuation			Threshold
	rate	month	rate	month	Average	Max	Min	Level
Kratie	0.16	Jun	0.15	Oct	14.08	18.85	12.4	14
					(17.96-3.89)	(1939)	(1988)	
Kampong Cham	0.14	Jun	0.1	Oct	11.63	13.58	10.84	10
			0.1	Nov	(12.61-0.99)	(1966)	(1989)	
Chrouy Changvar	0.07	Jun	0.07	Nov	7.70	9.27	5.48	7
	0.06	Jul			(8.55-0.85)	(1966)	(1988)	
	0.07	Aug						
Chaktomuk	0.07	Jun	0.07	Nov	8.49	9.29	6.56	7
	0.06	Jul			(9.12-0.63)	(1966)	(1988)	
	0.07	Aug						
Neak Luong	0.05	Jun	0.06	Nov	5.74	7.39	5.05	5
		Jul	0.06		(6.38-0.65)	(1966)	(1989)	
Koh Khel	0.06	Jun	0.05	Nov	5.46	6.1	5.33	5
	0.07	Jul	0.04	Dec	(6.16-0.7)	(1991)	(1993)	
Prek Kdam	0.07	Jun	0.07	Nov	7.8	9.45	6.36	7
	0.07	Jul	0.06	Dec	(8.68-0.88)	(1961)	(1988)	
	0.06	Aug						

Note: The figures below max. and min. range show the year of occurrence. And those below average range show the high and low level of average range. River water starts to flow into the colmatage canals when water level rises above the respective threshold levels. The threshold level are assumed and not verified.

(2) Discharge of Gauging Stations in the Study Area

Based on daily flood stage and rating curves re-charted for the respective stations, average monthly discharge of the stations in the Study Area was computed (see Figure 2.3). Except for Neak Luong and Chaktomuk, all other stations along Mekong follow similar trend in increase and decrease of discharge. The delay in increase and decrease and the smaller magnitude at Neak Luong and Bassac river are the corollaries of the reverse flow into Tonle Sap river at the beginning and the emptying of Tonle Sap Lake at the end of rainy season. At Prek Kdam, the reverse flow occurs from June to September. If all of the reverse flow is assumed to flow out again within a hydrological year, the ratio of reverse flow to catchment flow is about 1:3. The table below shows the maximum, minimum and the ratio between max. and min. discharge for the respective stations. The ratio is the highest (36.9) at Prek Kdam along Tonle Sap river, follows by Chaktomuk (29.9) at the confluence, the stations along Mekong (19.2-21.5) and Neak Luong (6.5).

Maximum, Minimum and Ratio of Max. and Min. Discharge

(Unit: m^3/s)

	Kratie	Kampong Cham	Chrouy Changvar	Neak Luong	Chaktomuk	Prek Kdam
Maximum	111.3	102.9	98.2	61.9	14.0	22.1
Minimum	5.8	4.8	5.0	9.5	0.5	0.6
Max/Min	19.2	21.5	19.6	6.5	29.9	36.9

(3) Water Balance of the Mekong River

Daily discharge were summated over a year for several years to estimate the mean annual discharge at the respective stations: Kratie 482.2 km^3, Kompong Cham 431.4 km^3, Chrouy Changvar 416.8 km^3, Neak Luong 358.9 km^3, Chaktomuk (Bassac) 58.6 km^3 and Prek Kdam 25.6 km^3.

Based on mean annual discharge water balance for the intervals between the gauging stations along Mekong was calculated, mainly to evaluate the outflow from Mekong into the colmatage canals and preks and the returning flow from the canals and preks into Mekong (see Figure 2.4). For example, for the reach between Kratie and Kompong Cham about 51,400 MCM flow out of Mekong as compared to 600 MCM flow in annually. It is also clear that more water flows out from Mekong between the reach Kratie and Kompong Cham than that between Kompong Cham and Chrouy Changvar. Within the later reach, the over-bank flow on the right bank of Mekong flows toward Tonle Sap Lake, in addition of the reverse flow through Tonle Sap river at Chaktomuk.

At Prek Kdam the annual flow, reverse flow and catchment flow are estimated at 71,400 MCM, 45,800 MCM and 25,600 MCM, respectively, showing that about 11% of Mekong water flows into Tonle Sap Lake annually.

(4) Basic Data for Planning and Design

Hydrological and meteorological observation during the period from 1971 to 1980 had been interrupted by Pol Pot regime and internal instabilities. Due to inadequate budget for operation and maintenance, hydrological measurements are conducted only at few rehabilitated main stations along the mainstreams at present. Verification of data record is difficult due to lack of or antiquated rating curves and uncertainty of some reference datum. The lack of data is felt most when planning for a more localized area. Uninterrupted daily rainfall data are not easily available for some locations even during the period which was not interrupted by internal chaos. More intense meteorological observation network is also needed for meteorological observation.

2.1.4 Inundation Conditions

Annual flooding cycle is life blood of Cambodia. It usually begins in August and starts to ebb in Oct-Nov. About 2/3 of the agricultural land in the flood plain is flooded during crest water level each year. It is alleged that the nutrient-rich silt-laden floodwater of Mekong and its tributaries is important to rice production. The repeatedly flooded forest in the flood plain and reserve forest on the peripheral of Tonle Sap Lake are vital to spawning and breeding life cycle of fish.

The flood plain, including the Tonle Sap Lake, is crucial to the well-being not only of Cambodia but also Viet Nam as well. It acts as a buffer or flood regulator of the lower Mekong basin, drawing off water during peak of the flood and adding it back later in the year. It also serves to limit salinity intrusion in the lower delta area in Viet Nam and the waters draining from the plain...(Cambodia, An environmental and Agricultural Overview and Sustainable Development Strategy, Michael D. Benge, USAID, 1991).

Topographically, except for the narrow strip along Mekong in Kratie province, the Study Area is generally below 30 m elevation and makes up the eastern and lower part of the Mekong Delta in Cambodia.

The table below shows the inundated area estimated from two sources: An existing study (***DES AGRO-ECOSYSTEMES DE LA REPUBLIQUE POPULAIRE DU KAMPUCHEA***, map 1:500,000, June 1986) showing average inundation condition (see Figure 2.5) and ***LANDSAT*** images (December 1994) procured for this study. December 1994 was chosen because a) the images would show recent rapid changes in land use. b) The flood in 1994 was quite severe and much of the Study Area was inundated. A check of rainfall shows that 1994 was about the intensity of a 1/10 return period. c) The images of Dec. 1994 obtained were the limited days with clear sky.

Area Inundated during Rainy Season

(unit: ha)

Duration	Negligible	Short	Average	Long		Total
AGRO-ECO	90,572	554,928	327,766	214,634	0	1,187,900
Depth (m)	0-0.3	0.3-1.0	1.0-1.5	1.5-3.0	>3.0	Total
AGRO-ECO	311,887	171,199	252,004	297,676	155,134	1,187,900
LANDSAT	554,760	114,344	165,632	159,976	193,188	1,187,900

Note: AGRO-ECO data were measured from Carte Des Agro-ecosystems, LANDSAT was estimated from LANDSAT images Dec. 1994. Short (3-4), Average (5-6), Long > 7 months

The data of *LANDSAT* shows that the area not inundated (0-0.3 m) is larger than that of *AGRO-ECO*, a trend as expected since much of the water would have receded by December of 1994. This is also true for area with inundation depth between 0.3-3.0 m, 720,879 ha of *AGRO-ECO* as compared with 439,952 ha of *LANDSAT*. The area of inundation depth >3 m for *LANDSAT* is slightly greater (25%) than that of *AGRO-ECO*. The *AGRO-ECO* data also show that about 74% of Study Area is subject to inundation during peak of flood period.

2.1.5 Water Quality and Siltation Survey

Water quality and siltation survey was conducted for river and well water to assess briefly the fertility of sediment brought by Mekong river and the suitability of river and well water for drinking purpose. Since the method adopted was a simplified preliminary test for the basic items the result is insufficient to evaluate the whole situation. Test for heavy metals and carcinogens was not included.

Water quality and siltation survey for dry (April) and wet (September) season was conducted at the same river and well water sampling locations (see Figure 2.6). In addition to the simplified in-situ test (pH, Ec, SS, DO, Temp, NaCl and C. Bacillus & bacteria), the wet season samples were transported back to analyze for the analytical items available at GDIMH laboratory.

River water samples of wet season, on the whole, show a lower pH value, higher SS content and lower temperature, when compared with dry season samples. The test for C. Bacillus & bacteria also show that they are somewhat diluted by the large deluge. The results suggest that the quality of river water, in terms of salinity and soil permeability problem (TDS & adjusted SAR), is within the acceptable ranges for irrigation water indicated in published guideline values. However, removal of suspended solid is required, especially during wet season, when it is intended for drinking purpose.

The difference in the results for well water samples between dry and wet season is insignificant. Except for the heavy metals and carcinogens of which no test was conducted, the river and well water can be used for drinking. However, as it is evident from the C. Bacillus test well water can be made safer for drinking by boiling or chemical treatment (see Appendix C).

Total suspended solids (TSS) in the river during dry season is insignificant, less than 10PPM. River water survey in the wet season of 1996 shows that Mekong, Bassac and Tonle Sap rivers contain about 900ppm, 400ppm and 80ppm of TSS, respectively. The data at GDIMH shows a lower value: 148-262ppm, 13-22 and 168-315 along Mekong, Tonle Sap and Bassac river,

respectively. TSS value also shows a decreasing trend as Mekong flows southward, indicating siltation along this reach. TSS of reverse flow in Tonle Sap river is much lower than that in Mekong, showing that much of the sediment is deposited downstream of Prek Kdam. River water in the wet season, with a TSS of 200ppm, was estimated to deposit about 5 mm thick of sediment in the flooded area.

2.1.6 Land Use

Agro-Ecosystem Map drawn by LUMO, MAFF, shows that the Study Area is covered by nine major units of vegetation. Six of them are defined as agricultural land and three of them are as forest land. About 62% of the Study Area is classified into agricultural land and about 33% is classified into forest land. Remaining area is composed of river and lake.

Among the five provinces which are included in the Study Area, three quarters of the provincial area in both Takeo and Prey Veng are occupied by agricultural land. In Kampong Cham and Kandal, almost half of the area is represented to agricultural land. Kratie has the least agricultural land occupation, 27%. About 10% of area in Kratie, Kampong Cham and Kandal provinces are presented in river and lake (see Figure 2.7).

Based on the remote sensing analysis data, the land under agricultural utilization occupies 41% of the Study Area. This figure is lower than the data obtained from Agro-Ecosystem Map. There are several possible reasons for this discrepancy. The photo images were taken in January and February, 1995, but the map was drawn in late 1980s, so, firstly, the actual land use may change during this period. Secondly, the remote sensing analysis includes more legends (12 legends) than Agro-Ecosystem Map (9 legends) so other legends such as waste land, grassland, may include some areas that were classified into agricultural land by Agro-Ecosystem Map.

2.1.7 Soil Distribution and Nutrient Supply Effect by Flood

(1) Soil Distribution

Systematic soil surveys in Cambodia started in the early 1960's. The classification of the nation's soils based on the 1938 USDA soil taxonomy was presented by Charles Crocker (1963). Subsequent soil studies were generally based on Crocker or were translations of Crocker's study to other classification system.

Based on the Soil Map prepared by LUMO, MAFF, the Study Area comprises eleven soil units. Alluvials, Cultural Hydromorphics and Brown Alluvials are the dominant soil units and each soil unit covers 55, 18, and 12% of the Study Area. With good farm management, high yields of paddy are generally expected on those three units. Acid sulfate soil, which is partially observed in the tropic and becomes one of the agricultural constraints, is not distributed in the Study Area (see Figure 2.8).

(2) Nutrient Supply Effect by Flood

To grasp the influence of nutrient supplied by the flood of the Mekong, fourteen soil samples were collected and analyzed in twice. Eight soil samples, including two controls, were

collected from both left and right banks of upstream, middle and down stream along the Mekong, which receive severe annual flood. Six samples were collected from both banks of upstream, middle and down stream away from the Mekong, which receive less severe annual flood. First analysis was conducted by the Study Team with portable soil nutrient tester adopted colorimetric method and second one was done by Soil Laboratory, DOA, MAFF.

But two analyses do not indicate distinct differences between two groups; the soil samples along the Mekong and those away from the Mekong. Only one item of portable tester analysis, exchangeable potassium, shows significant difference between two groups at five (5)% level, but there is no significant difference in laboratory analysis.

In the past studies, there were two kinds of results. One report suggests that the soil samples collected within the zone of flooding in Kandal and Prey Veng are considerably richer on available potassium, magnesium, calcium and phosphorus (J.V.Dennis Jr., "Kampuchea's Ecology and Resource Base : Natural Limitations on Food Production Strategies"). But there is also another report that says there is no difference of the phosphorus, nitrogen and manganese contents between the near Mekong River Delta bank and far away Mekong River Delta bank in Viet Nam (University of Hawaii, "The Comparison of Mekong River Silt and its Possible Role as a Source of Plant Nutrient in Delta Soils", Mekong Committee, 1985).

Although there is not clear difference between two groups in terms of nutritious contents, yet the number of analyzed samples is very limited. Moreover, the farmers along the Mekong, Bassac and Tonle Sap rivers generally know that flood water and sediments bring better harvest from their experiences. Therefore it can not be concluded that the soils along the Mekong do not contain more soluble nutrients than the soils away from the Mekong.

2.2 Socio and Agro-Economy

2.2.1 Population

Population and population density in the Study Area were estimated based on the statistics collected by provinces and districts. Acreage of the Study Area of 1,188,000 ha and population of 3,440,930 are corresponding to 6.6% and 25.5% of the whole country, respectively. The Study Area is populated with higher population density of 289 persons per km^2 compared with 51 km^2 of the national average.

Population Density

Province	Population	(persons/km^2)	Family Size
Kratie	11,320	21	5.6
Kampong Cham	596,940	154	5.6
Kandal	1,725,840	476	5.2
Prey Veng	684,640	203	5.4
Takeo	422,190	211	5.4
Total	3,440,930	289	5.4

2.2.2 Food Security

The First Socio-economic Development Plan estimates that a 3.0% increase in paddy production would be needed over next 10 years to maintain country demand. This is equivalent to a 2.7% annual increase, which is almost the same as the overall population growth of Cambodia. The major problem to be solved on food security is instability of paddy/cereal production which is greatly affected by annual rainfall and flooding conditions causing flood and drought damages on crops.

Average farm size of 1.20 ha per farm household in the Study Area is considered not enough to produce paddy for family consumption, implying that the subsistence agriculture is predominant. It is said that there are categories of farm households in Cambodia classified by availability of paddy for family use, that is, rich households, poor households and marginal households. On the estimation, one family with 5.5 family members will consume about 1,400 kg of paddy a year, which is equivalent to 253 kg per capita per year. In considering averaged paddy yield of 1.49 ton/ha, at least 0.94 ha of farm size will inevitably be necessary to meet family consumption. Among 36 districts, in which Rural Socio-economic Survey was carried out, 30% of which does not meet 0.94 ha and 42% of the districts does not meet district's demand for paddy, particularly in Kratie and Kampong Cham.

2.2.3 Agricultural and Fisheries Production

The Study Area produced about 1.03 million ton paddy with 679,000 ha of cultivable areas, corresponding to 47% (1994) of the total paddy production of the country. There are some structural differences in agricultural production among provinces and districts. For example, Prey Veng province produces the largest gross crop production value (GCPV) among five (5) provinces in the Study Area, however, 97% of which is come from paddy production. On the contrary, Kandal province shows different structure in GCPV so that 58% of GCPV is originated by paddy and 42% by other upland crops. This indicates that agriculture in Kandal province has been developed with crop diversification, and colmatage canals contributes to attaining higher cropping intensity and the promotion of diversified farming. Kandal province is blessed with condition for transportation of agricultural products to Phnom Penh in which more than 830,000 people are populated, indicating that the districts near the capital has higher potential for diversified farming.

As for fishery production, Kandal province has the highest production as shown below:

Gross Production Value

Province	million Riels/year
Kratie	3,750
Kampong Cham	8,850
Kandal	31,250
Prey Veng	11,250
Takeo	4,625

Table 2.1 shows the demarcation of the Study Area in agricultural sector.

2.2.4 Land Tenure and Land Holding

The national assembly revised the constitution in June 1989 to permit private ownership of land under the three categories:

Private land title: for the house and houselot where "market gardening, tree cropping and small-scale animal raising are carried.

Possession or usufruct rights to state: owned land, which is inheritable.

Concession (usually for 10 to 15 years): for surplus or land worked in excess of a farmer's holding as long as it can be demonstrated that he/she has the means to cultivate it.

The Rural Socio-economic Survey showed that 97% of the farmers interviewed have the land titles mentioned above. Average farm size in each province shows difference among five provinces:

Farm Size

Kratie	0.95	(ha)
Kampong Cham	0.78	
Kandal	1.10	
Prey Veng	1.59	
Takeo	2.07	

2.2.5 Poverty Line

In the First Socio-economic Development Plan (1996-2000), eradicating poverty is considered as the single most important objective of Cambodia because poverty causes lower life expectancy or higher under-five mortality, illiteracy of people, higher growth of population, social security and so on. At present around 38% of the households and 30% of the population are estimated to be poor which are living on income lower than poverty line. The highest incidence of poverty is in the rural areas. Ministry of Planning estimates that since the rural areas contains 85.4% of the total population, 90% of poverty is in rural areas. Female-headed households and small holders are considered as particular beneficiaries of the governmental poverty alleviation strategy.

Poverty Incidence (%)

	Cambodia	Phnom Penh	Other Urban	Rural
Households	38	24	35	40
Persons	30	19	27	32
Poverty Line (Riels/month/family)	NA	371,533	223,220	185,835

Kandal province shows the highest farm household income among five provinces followed by Kampong Cham, however, those incomes are classified lower income than poverty line of

185,835 Riels/month/family (2,230,020 Riels/year) excluding one (1) district in Kandal. Therefore poverty alleviation is the most important issue in the Study Area, too.

2.2.6 Farm Economy

Farm household incomes are composed of three (3) categories, that is, farm income, fishery income and off-farm income. Annual farm household income was accounted based on the result of the Rural Socio-economic Survey. As shown below, there are income disparity even in the Study Area and annual family incomes in the five (5) provinces are lower than poverty line of 2,230,020 Riels of the national average of rural areas.

	Farm Household Income (Riels/year)	of which	
		Farm Income (Riels/year)	Farm Income/ Living Expense (%)
Kratie	672,632	654,000	84.8
Kampong Cham	916,953	679,256	58.6
Kandal	1,357,852	1,199,313	94.2
Prey Veng	672,630	623,987	71.7
Takeo	803,567	803,567	103.0

Source: Rural Socio-economic Survey, 1996

There are some differences in the structure of agricultural production and land use in provinces, and this has resulted in disparity of farm income. Kandal province in which crop diversification has been developed shows the highest. However, farm incomes in the four (4) provinces does not meet living expenditure excluding Takeo, implying necessity for fishery income and off-farm incomes. It is considered that these income disparity among provinces and districts are caused by the geographic condition of farmlands, flood, irrigation water availability and so on.

2.3 Agriculture

2.3.1 Agricultural Land Use

The agricultural land use situation in the Study Area is decided by natural conditions, particularly in wet season. During the period of high flood water level, the land is widely covered by flood water. The duration and the depth of flood varies by location but vast inundated area can not be utilized. The huge flat areas of the northern and middle part of Prey Veng, the north-west part of Kandal and the north-east part of Takeo receive shallow and short-period flood. Rainfed paddy cropping is the main activity in those areas.

On the other hand, during dry season, from November to April, the availability of irrigation water is a vital factor for agriculture. Generally, these farming areas are located along the Mekong and the Bassac and around lakes (boeng). There are some areas where irrigation systems are constructed, such as Kampong Sne, Prey Veng, but not common.

The data obtained from Agro-Ecosystem Map, LUMO, MAFF, show that about 60% of the Study Area, 739,000 ha, is classified into agricultural land. Wet season paddy area occupies the

largest distribution 71% of agricultural land and followed by cereals and annual crops; 14%, floating rice; 9%, dry season paddy; 4%, and rice and cereals; 1%.

The results of remote sensing analysis indicate relatively small area (about 476,000 ha) for agricultural land which comprises dry season paddy, wet season paddy, upland crops, and plantation. This area difference may come from the interpretation of photo images for idle land area; waste land, grass land and swamp, which is not shown in Agro-Ecosystem Map. Another difference between two analyses is the distribution of each item. Dry season paddy area of remote sensing analysis is further bigger than that of Agro-Ecosystem Map (see Table 2.2).

2.3.2 Farmers and Farmland Holding

According to the Rural Socio-economic Survey (referred to 2.6.2), 872 farmers are land owned ones among 900 interviewed. Less than 3% of them (25 farmers) are tenant farmers and three farmers are unknown (see Table 2.3).

Average area of titled land is 1.19 ha but five provincial averages vary from 0.78 ha in Kampong Cham to 2.07 ha in Takeo. About half of farmers in Kampong Cham have titled land less than 0.90 ha but 45% of farmers in Takeo have titled land more than 1.80 ha (see Figure 2.9).

Land owned farmers are also divided into two kinds, 855 paddy practicing farmers and 17 not paddy practicing farmer. Following analyses are basically based on the 855 paddy practicing farmers who represent 95% of all respondents.

From the viewpoint of paddy practicing season, 855 paddy practicing farmers are classified into three types, namely, 232 wet season paddy practicing farmers (27%), 326 dry season paddy practicing farmers (38%) and 297 both wet and dry season paddy practicing farmer (35%). Only in Kampong Cham, wet season paddy practicing farmer is the largest of the three types. On the other hand, dry season paddy practicing farmer is dominant in Kandal where most land is flooded in wet season. The histograms of titled land area by the three farmer types of paddy practicing season are analyzed but they are almost same. It means that the provincial difference of titled land area is bigger than that of the farmer types of paddy practicing season.

In terms of upland crops, 452 land owned farmers practice some upland crops, which represents 52% of land owed farmers. Generally, dry season paddy practicing farmer has high introducing ratio of upland crops, about 70%. On the other hand, only one third of wet season paddy practicing farmers introduce upland crops. The ratio of both dry and wet season paddy practicing farmer is intermediate, 45%, but only in Kandal, about 70% of them introduce upland crops. In Takeo, only one quarter of all farmers introduce upland crops, but in other four provinces, about half of farmers introduce them (see Table 2.4).

2.3.3 Crops and Farming Practices

Based on the results of the Rural Socio-economic Survey, 36 crops are cultivated in the Study Area except for paddy. Five common upland field crops are maize, cucumber, mungbean, tobacco and sesame. Among them, maize is the most popular field crop in the Study Area, which is cultivated by 264 farmers (58% of upland crop practicing farmers). Cucumber is

broadly cultivated in the Study Area but tobacco and sesame are cultivated mainly in Kampong Cham and mungbean is mainly in Kandal.

Average number of practicing upland crops per farm in the Study Area is two crops and this is derived from the fact that three quarters of upland crops practicing farmers perform one/two crops farming except for paddy. One farmer in Prey Veng practice seven upland crops but the farmers who practice more than three upland crops are few in the Study Area (see Table 2.5).

There are nine main cropping patterns of wet season paddy in the Study Area as shown in Figure 2.10. Among them, dominant patterns in the Study Area are W-2, W-3, W-5 and W-6. Total of W-5 and W-6 represents 39% and that of W-2 and W-3 represents 26%. There are also nine main cropping patterns of dry season paddy. Dominant patterns in the Study Area are D-3,D-5, D-6 and D-8, and those four patterns count for more than 60% of all. In the Study Area, there are some farmers who practice double cropping of paddy but it is limited only for those who can secure enough seedlings and irrigation water all year round.

In the Study Area, the majority of wet season paddy is traditional variety. There are 61 wet paddy varieties and medium/late duration varieties are dominant. Variety "bonla pdau" is the most popular variety in wet season and 24% (127/529) of wet season paddy farmers cultivate it. On the other hand, IR varieties are common for dry season and more than 80% of dry season paddy practicing farmer use them. IR 66, IR 36 and IR 42 are the major varieties and these three varieties count for 480 out of 623 dry paddy practicing farmers.

Generally, each farmer keep rice seed by himself. According to the Rural Socio-economic Survey, 94% of paddy practicing farmers (784/835-20 farmers are unknown) use self keeping rice seed customarily. Governmental rice seed distribution does not seem to function well.

It is said that the Cambodian agriculture is generally extensive but the farmers in the Study Area usually use fertilizer. The Rural Socio-economic Survey shows that those who use fertilizer represent 82% of paddy practicing farmer (674/821-34 farmers are unknown) and in Takeo every farmer uses it. Urea and 16-20-0 are common fertilizers. Applying agricultural chemicals, particularly insecticide, is also familiar among dry season paddy farmers in the five provinces. Methyl-parathion and Monocrotophos are commonly used.

Farm labor entirely depends on manual works and draught animals. On the average, a farmer has 4.25 agricultural labors (2.05 men and 2.20 women) and two draught animals including calves, but 20% of paddy practicing farmers (171/855) do not have any draught animals and 96 of them rent draught animals from others.

Among 855 paddy practicing farmers, only 36 farmers (4%) responded that they had their own agricultural machines but they are all limited to mobile pumps for irrigation. Generally, irrigation is conducted by traditional manual method called snach or rohat. But interview of farmers shows that some farmers rent mobile pumps from others. A few rich farmers own 4-wheel tractors and provide tractor plowing as contract work but the number of tractor is still very small.

2.3.4 Production and Yield

From the five provincial agricultural offices, production and area data of paddy and five major upland crops in each province were collected. The five major upland crops were selected by provincial staff so the data of some crops are not completed for five province . Collected data are modified with the district area distribution of the Study Area (see Table 2.6).

Share of natural area distribution of the Study Area of five provinces is only 37%. Both paddy area and production of the Study Area occupy more than 60% of whole five provinces data, in particular, about 80% of dry season paddy production comes from the Study Area. This tendency is strong among four of five upland crops except for sweet potato. Dry season cropping of the Study Area represents 79 to 95% of production and 85 to 94% of area , respectively.

Yields of both wet and dry season paddy of the Study Area are 4% higher than the yields of five provinces. Yields of vegetable and sesame are lower, but those of maize, mungbean and sweet potato are higher than the yields of concerned provinces. Yield of wet season mungbean is 78% higher than the yield of five provinces.

From the Rural Socio-economic Survey, average yield of wet season paddy is calculated as 1.47 ton/ha. The average yield of Prey Veng is the lowest, 1.12 ton/ha, among the averages of five provinces and this is attributed to low productivity, less than 1.0 ton/ha, of some districts located away from the Mekong, such as Kanh Chreach, Prey Veng and Kamchay Mear. In terms of dry season paddy, average yield is calculated as 2.77 ton/ha. Both Kandal and Takeo have the higher average than that of the Study Area. Those two yields from the Rural Socio-economic Survey are lower than the yields calculated from provincial data, 1.75 ton/ha in wet season and 3.43 ton/ha in dry season. Some FAO report indicates that forecasts made by farmers are generally understated and this discrepancy between two yields data may be caused by farmer's understatement.

The two third of the farmers who practice only wet season paddy feel that the paddy production is not enough for them, particularly in Kampong Cham. Those figures of dry season paddy practicing farmers are lower than that of only wet season practicing farmers and this may come from the result that the average yield of wet season paddy is lower than that of dry season paddy.

2.3.5 Livestock

Livestock still plays a vital role in the farming system and meal in Cambodia. Generally, most of farmers depend on draught animals, cattle and buffalo, for cultivation and transportation. Livestock such as beef, pork, chicken is the important animal protein source for Cambodian people as well as fish. It is estimated that total annual animal protein consumption per capita is 26.4 kg, and more than half of it comprises livestock, 8.5 kg of pork, 3.3 kg of beef and 2.8 kg of poultry.

A pair of bullocks is used for cultivation and harrowing works. Some 15 to 20 days are necessary to prepare one hectare of paddy field by a pair of bullocks. Hariana of the Indian cattle, which is generally called as Zebu, is popularly used for draught works.

Major sources of feed for cattle are wild grass for wet season and paddy straw for dry season, and stubble grazing is also practiced after harvesting paddy. Cattle manure is used as the important natural fertilizer. Pig fattening and chicken raising are popularly observed in rural areas but in small scale.

The number of draught animal per one hectare of paddy field in concerned five provinces is as follows: Kratie - 0.5, Kampong Cham - 1.2, Prey Veng - 0.5, Kandal - 0.9 and Takeo - 0.8 (head/ha). Those figures are insufficient and price of bullocks is quite expensive for poor farmers. Some agricultural institutions provide draught animal loan and cow bank by lending adult cow to farmers with feed for calves. National Cattle Breeding Center in Takeo, which is managed by the Department of Animal Production, MAFF, provides about 100 cattle every year to meet demand but it is not yet enough.

2.3.6 Forestry

The data obtained from Agro-Ecosystem Map, LUMO, MAFF, show that about 33% of the Study Area, 387,000 ha, is classified into forest land, which consist of bush, inundated forest and forest. Vast bush lies between the Mekong and the Bassac rivers. Inundated bush is largely distributed to Prey Veng, Takeo and Kandal. Kampong Cham occupies more than three quarters of whole forest in the Study Area. For Cambodian economy, logs and sawn timber are one of the major exports these years, but they are not produced in the Study Area.

Those forest areas have several important roles for rural people. They provide firewood for energy supply and the material for houses. The infrastructure conditions, electricity and gas, in rural areas are poor, so that rural people need to use firewood continuously. Another important function is environmental one, regulating flood water from the Mekong and the Bassac rivers. Inundated bush has a function of hatchery for fish, too.

From the results of remote sensing analysis, forest land represents 21%, 15% of forest and 6% of inundated forest, of the Study Area. This figure is 14% smaller than the data of Agro-Ecosystem Map. Those areas are probably included in the legends of waste land or grass land or swamp of remote sensing analysis.

2.3.7 Women in Agricultural Activity

So far, it is said that woman labor has a great role in Cambodia resulting from long civil war. From the Rural Socio-economic Survey, average agricultural woman labor per farm is larger than that of man labor although the difference is small. Among 855 paddy practicing farmers, those who have more man labor than woman labor represent 26% but those who have more woman labor than man labor represent 36%. This tendency is common among three types of paddy practicing farmers but in two southern provinces; Kandal and Takeo, woman labor for agriculture seems to have greater role than other provinces (see Figure 2.11).

Half of daily working hours of woman are still dedicated to farming practices. Women usually do not work for plowing or harrowing which needs draught animals but work for transplanting or harvesting.

2.4 Agricultural Supporting Service

2.4.1 Agricultural Research and Extension Service

(1) Agricultural Research Activity

Agricultural research activity is conducted by 18 national institutions managed by the Department of Agronomy, MAFF. Fourteen institutions operate research activities on rice as their main subject crop. Former Samrong Thom Research Station for tobacco was sold to a private company (see Table 2.7 and Figure 2.12).

Basically, six research stations have a main role to operate research activities but most of them train both staff and farmer and some of them produce seeds to support state farm activity. The main activity of five agricultural development centers is extension and training service for both staff and farmer. They also demonstrate new technology on farm/station and distribute agricultural materials to farmers. Three rural development centers have similar roles of agricultural development centers but they provide a more wide range of service, such as credit, raising animals, etc. Four state farms primarily work for seed production.

Generally, the activities of those research institutions are not active due to lack of able staff and enough budget at present. Some institutions receive assistance from foreign NGOs and seems to operate their works more actively than others, but there are only three of them.

(2) Extension Service

Agricultural extension service is officially managed by the Department of Technique, Economy and Extension, MAFF. Field service is practically operated by the provincial staff of the Economy, Extension and Techniques Office of provincial agricultural office. Generally, agricultural extension workers are trained in Prek Leap Agricultural College and Royal University of Agriculture (former Cham Car Daung Agricultural Institute) (see Table 2.8).

From May, 1996, Australian government starts the official assistance for agricultural extension service, named "Cambodia Australia Agricultural Extension Project (CAAEP)". Four main components of the project are as follows:

- Establish an operational national agricultural extension system
- Strengthen agricultural education
- Enhance village capability to improve agricultural productivity, food security and income through the extension system
- Establish a monitoring and evaluation system to enable proper project reporting

To achieve the target, the project will also strengthen the capacity of the Technical Department and train 484 agricultural extension workers who will be working in 968 communes in 21 provinces. The project is expected to complete its objectives by November 2000.

2.4.2 Processing and Marketing

(1) Agricultural Processing

In the five (5) provinces, there are some medium to large scale agricultural processing factories which mainly exist in and around Phnom Penh. However some of them are not in operation. Following are the major processing factories in Phnom Penh related to the agricultural sector:

Agricultural tool factory	1 place (s)
Fertilizer (phosphate) factory	2
Milk factory	1
Winery	1
Cigarette	6
Bran oil factory	1 (not working)
Leather factory	1

In the rural areas, at present, ricemills are the major agricultural processing activities, which are distributed nearly in each village. However, these are used for milling rice for family consumption use, not for commercial utilization, by collecting milling fee of 35 Riels per kg of paddy. In case, customers do not need rice bran, which is by-product of paddy, milling fee is not charged. Milling rate is estimated at 63% on an average.

For example, in Kompong Cham and Prey Veng districts for which number of ricemills was available, there are 3,112 ricemills which corresponds to about 2 places per village.

Other than those small scale ricemills in the rural areas, there are some medium scale ricemills managed by private owner, most of them are also a wholesaler, located along national roads. Purchasing price of paddy from trader and farmers at ricemills ranges between 300 Riels/kg and 500 Riels/kg. Ex-millprice of white rice is from 500 and 900 Riels/kg depending on its quality. Milling condition is the same as that of the small scale one so that milling fee become free of charge when customers do not need rice bran. Price of rice bran at ricemills costs at 200 Riels /kg, however, owner of ricemills sells rice bran to a market as animal feed at about 250 Riels/kg.

Because of unsuitable storage condition at ricemills, it is reported that about 2% of paddy/rice are lost during storing procedure.

(2) Marketing of the Products

The Rural Socio-economic Survey shows that the rate of farm households not selling paddy to market was generally higher implying that paddy production in the Study Area is mainly for home consumption use. The balance of paddy in each district can not always meet district demand. Among five (5) provinces, only two (2) provinces, Prey Veng and Take, met the district paddy demand.

The main agricultural product on marketing channel is paddy which occupies about 90% of planted area of Cambodia as a principal food of the Cambodian people. However, no formal organizational marketing activities are observed. At present there are two (2) channels for paddy marketing as shown below:

Farmers—> Ricemill —> Wholesalers —> Consumers
Farmers—> Traders —> Ricemill —> Wholesalers —> Consumers

The major problems on marketing paddy are low price of paddy and instability of price.

Vegetables and maize are marketed mostly on the same channel as shown below:

Farmers —> Middlemen —> Consumers
Farmers —> Market —> Consumers

In harvesting season, middlemen go to farmlands to purchase products and transport them to market by truck. When farmer goes to market to sell farm products by themselves, own or hired motorcycle are used. Hired rate of motorcycle is 4 Riels/kg/km. Averaged farmgate prices of maize is estimated at 230 to 300 Riels/kg, and 400 to 500 Riels/kg for leafy vegetables. Vegetable prices fluctuate seasonally depending on its production from 300 to 2,000 Riels/kg.

Fattened pigs with a body weight of about 70 kg are marketed through trader's motorcycles and trucks.

COCMA (Central Company of Agricultural Materials) is responsible for distribution of fertilizers, which are donated through KR II etc., to farmers through a provincial agricultural offices at the government prices. Other than COCMA, farmers can get fertilizer and agricultural chemicals from a private dealers at higher prices than government one.

2.4.3 Agricultural Credit

At present institutional credit is not available in Cambodia. Despite of 31 commercial banks in Phnom Penh, none of them offers rural credit for smallholders and rural households. Various informal credits are available in the rural areas enforcing farmers to repay at higher interest rates. In the First Socio-economic Development Plan (1996 - 2000), the need for rural credit and poverty alleviation are emphasized. Some 30% of the farmers in the Study Area is in debt borrowing money from relatives, neighbors, money lenders and so on.

To prevent farmer's disadvantage in crediting, many NGOs such as GRET, ACLEDA, PRASAC, World Relief, etc. support rural people by providing agricultural credits.

GRET (Group De Recheche Et d' Echanges Technologiques Project Credt Rural), French NGO, starts its activities in 1991, covering three (3) provinces of Kandal, Prey Veng and Kompong Speu. It is estimated that about 70% of the total amount of lent money is used for agricultural use and 30% for livelihood. The interest rate applied for GRET credit 4% per month with maximum amount of 150,000 Riels (60 US$) in cash. Due to good solidarity among farmers/members, ratio of repayment at present is reported 100% in the three (3) provinces. Before starting lending in the villages, GRET investigates farmer's solidarity by holding assembly for the explanation of GRET lending system. Those GRET activities have subsequently been linked to the Ministry of Agriculture, Forest and Fisheries through the rural credit Bureau of the Department of Agricultural Extension.

Rice Banks are managed under the rural development centers, which are supervised by the Department of Agronomy. There are two centers in Kandal province and one in Kampong Speu. The purpose of this bank is to alleviate farmer's debt by lending paddy and money

particularly for poor farmers. Applied interest rate is 2% per month for paddy and 3% per month for money, respectively. For example, there exist 65 Rice Banks in Kandal Stung district in Kandal Province. Some 65 farmer clubs are organized to manage this system in collecting responsibility of farmer/members.

2.5 Agricultural Infrastructures

2.5.1 General

Type of farm production system in the Study Area is categorized into lowland irrigation agriculture around swamps and lakes, colmatage farming along the main rivers and rainfed agriculture in higher elevation land. As the agricultural infrastructure facilities, colmatage canals, intakes and feeder canals, reservoirs, dikes and pumps are provided in the lowland irrigation agricultural area and the colmatage farming area.

2.5.2 Lowland Irrigation System

(1) General

Lowland irrigation system is distributed around the temporary and permanent swamps and lakes to irrigate lowland crops. The irrigation system was studied based on the report of 'Irrigation Rehabilitation Study in Cambodia', Halcrow 1994) and site investigation of four (4) Provinces, except for the Kratie Province due to the security problems.

The irrigation system consists of combination of canals, dikes, reservoirs and/or small pumps and traditional lifting. According to the study results, there are 292 existing systems numbers having a total irrigation area of 33,650 ha in the wet season and 75,789 ha in the dry season. These figures exclude the systems with the area of less than 10 ha. Of the total of 292 systems, 173 (59%) systems were constructed between 1975 and 1979 in Pol Pot regime. 218 (75%) systems are partially operational or not operational, gravity irrigation system (69) and gravity & mobile irrigation system (48) for show 24% and 16% to the total respectively. Wet season single cropping is currently cultivated on 31 system (11%) and dry season single cropping and double cropping are accounting for 190 (65%) and 71 (24%) respectively. Dual purpose pumps, for irrigation and drainage exists in the Hun Sen Development Center in Saang District, Kandal Province. There are few drainage systems in the Study Area (see Table 2.9).

(2) Present Condition of the Each Province

In Kratie province, there are 52 irrigation systems of which, 41 (78%) were constructed during Pol Pot regime. Water sources are all reservoirs stored by flooded water of the Mekong river in the wet season. Intake facilities from the reservoir are mainly gravity canal and mobile pump or gravity. Dry season single cropping of 1,671 ha only is currently carried out. The facilities problems are collapsed embankment of the reservoirs, inadequate intake facilities and shortage of the irrigation canals. Pumping stations are not in existence.

In Kampong Cham province, there are 46 irrigation systems with an irrigation area estimated at 13,393 ha in the wet season and 6,093 ha in the dry season. Out of them, 27 (59%) were constructed during Pol Pot regime. Water sources of 38 systems are mainly reservoirs and

lakes and water is released by gravity, traditional lifting (Snach or Rohat) or mobile pump for supplementary wet season irrigation and a small dry season area. Also polder dikes are constructed to prevent irrigation area from flood water in the wet season. Due to poor compaction and using unsuitable materials without stripping vegetation or its roots and topsoil from the foundation, embankments were broken by rainfall erosion or piping.

In Kandal province, the existing systems are 64 in numbers having a total irrigation area of 11,572 ha in the wet season and 18,198 ha in the dry season. 45 systems were constructed during Pol Pot regime and only five (5) were constructed after 1980. Water sources from the main rivers and these tributaries are utilized in 12 systems and almost all of flood controlling systems are broken and needs to rehabilitation. There are eight (8) pumping stations in the area and three (3) of them are fully operational. Others are partially operational or not operational due to breakdown of the pumps or missing parts. Neither the district nor the villagers have sufficient funds or technical back-up systems for repairs or replacement. And also there are 51 systems whose number of reservoirs and almost all of these dikes collapsed and intake facilities are too old to use. Water is introduced from the reservoirs by gravity canal or mobile pumps with capacity ranging from 10-30 l/sec.

In Prey Veng province, there exist 95 systems having a total irrigation area of 5,700 ha in the wet season and 17,252 ha in the dry season. 84 systems were constructed during Pol Pot regime or before and 11 were constructed after 1980. There are six (6) pumping stations in which four (4) are partially operational and two (2) were not operational. Water sources are mainly dependent on the reservoirs that stored flood water in the wet season. Embankment of reservoirs, intake facilities and canals need rehabilitation.

In Takeo province, there exist 35 systems having a total irrigation area of 2,985 ha in the wet season and 32,570 ha in the dry season. 32 systems were constructed during Pol Pot regime or before and three (3) were constructed after 1980. Irrigation water for supplementary use is introduced by gravity or mobile pump from the Stung Takeo but there are no flood controlling systems. These irrigation areas have a generally large-scale flooding problem and dredging of the Stung Takeo is required urgently. In the area, there are four (4) pumping stations and all are partially operational due to the same reasons as Kandal province. And also, there are 32 irrigation systems irrigated by reservoirs whose embankment intake facilities and canals are in need of rehabilitation.

Details of the inventory in each province area shown in Appendix D.1.

(3) Pol Pot Irrigation Facilities

Pol Pot Irrigation Systems constructed during 1975-79 are estimated at 173 (59%) against the total of 292. Almost all facilities were not useful due to poor planning and design. It also made negative environmental impacts in the Study Area. But some flood protection dikes such as Tamouk Reservoir dike in Ponhea Leu District or new road from the National Road No.1 to Saang District which was initially constructed as a protection dike but rehabilitated by Hun Sen Fund in 1995 are still useful as a function of road and protection dike. Special features of the Pol Pot system are summarized as below.

- The typical grid pattern of canals at one kilometer intervals did not consider the hydrological aspect. Accordingly, it accelerated drainage from higher areas and prevented drainage from lower area.
- Long canals were constructed disregarding catchment boundaries. These canals block natural drainage systems and cause flooding.
- Concrete structures were built without adequate foundations or erosion protection so that these facilities were broken by piping or settlement.
- Intake gates along the colmatage were constructed but not operational due to poor design.
- The diversion structures were often located too far downstream with inadequate flood discharge capacity so that they cause flooding in the upstream areas.
- Embankments were constructed using unsuitable materials without stripping vegetation or its roots and topsoil from the foundation were not properly compacted so that they failed from rainfall erosion or piping.

2.5.3 Colmatage System

(1) General

In the Study Area along the Mekong, Bassac, and Tonle Sap river, "Colmatage" farming systems are practiced. This is a traditional land reclamation method in which canals were dug through the natural levees of the rivers in order to introduce silt- bearing flood water to behind the levees or area where farmers wish to create an arable land. Most of the colmatage areas are liable to inundation with the deposition of fertile silt. By the early 1940s, some 370 colmatage canals existed in Kandal province.

Table 2.10 shows the number, canal dimension, irrigation area and yield of colmatage in each province studied by the team. The inventory recorded 386 colmatage systems having a total area of 18,599 ha in upland crops, 6,972 ha in the wet season rice and 52,978 ha in the dry season rice. These figures exclude systems of Prek Prasap and Chhlong district in Kratie province and Ksach Kandal and Lvea Em district in Kandal province because the security problems have restricted access in these areas. According to the irrigation statistics in 1967, the colmatage irrigation area was 17,600 ha in total including Kampong Cham and other provinces. An agricultural lands in colmatage systems from 1967 to 1996 (30 years) increases about four (4) times. This means the farmers might have reclaim waste lands or forests along or behind the canals. (Details of the inventory results are shown in Appendix D.1.)

(2) Present Condition of Colmatage Canals in Each Province

In Kampong Cham province, there are 78 colmatage systems having a total area of 7,152 ha in upland crops, 71,260 ha in the wet season and 5,064 ha in the dry season. Water source depends on the Mekong river but intake facilities at the entrance of canals are few. Due to silt deposit, the canals become shallow. Farmers mainly use the mobile pump or traditional lifting in dry season. Farmers request to dredge the canals and construct the intake gate facilities.

Kandal province has the biggest colmatage systems and the systems are utilized actively in the Study Area. The number is 254 (66%) out of the total 386 systems. The irrigation areas

totaled 7,937 ha in upland crops, 5,512 ha in the wet season and 14,774 ha in the dry season, respectively.

- Muk Kampoul District

  There are four (4) colmatage systems along the National Road No.6A. All were constructed before 1961 and has no intake facilities. The canals are shallow due to the deposition of silt. The farmers use mobile pump and traditional lifting for dry season cropping.

- Kean Svay District

  Along the National Road No.1, there are 22 colmatage systems constructed before 1968. Only 10 systems have intake gates which were rehabilitated during 1975-78 in Pol Pot regime. Due to inadequate design and deterioration, the intake gates are not operational. The intervals of colmatage canals are farther as compared with other colmatage canal systems. The farmers long for the rehabilitation of gates and the dredging of canals. Because this area is near Phnom Penh and has good road condition, the priority of agricultural development is very high. (The rehabilitation of six (6) colmatage systems has been requested to Japan. Intake gates of them are not functional. With the rehabilitation of canals and intake gates, water siltation would be conducted more effectively. The area has the greatest possibility for expansion of agricultural land.)

  Recently, land reclamation has become active between the Mekong river and the National Road No.1 by private sectors. Due to the land reclamation in this area, some of existing colmatage canals were filled up and not functional. This activity will not only damage the colmatage system but also cause negative impacts on the watercourse of the Mekong river. Monitoring in this matter should be taken care by the government.

- Koh Thom and Saang District

  The colmatage systems in both districts of total 177 which is 46% out of total province. In this area, a plantation of banana, maize, beans and green chili, etc. is the most active in the Study Area. The farmers use mobile pump and traditional lifting for supplementary wet season irrigation and small dry season area. Intake facilities are very few and not useful, so that the farmers make a dike at from 0.5 to 1.0 km upstream of the entrance of the canal until middle of August to protect the planted crops from flood water, after harvesting the dike is demolished to introduce flood water to the field every year. Almost all of the bridges are wooden and too old. Villagers request to construct concrete bridge and dredge the canals. GDIMH has planned to rehabilitate 12 colmatages in the area. At present, intake gates have been installed at 13 canals in Saang and 8 in Koh Thom. But, all of them are not functional. The average canal interval is about 700 m, which is nearest in the Study Area. Upland field is gradually expanding by accumulating sedimentation and agricultural activities are the most active compared with the other districts.

- Leuk Dek

  There are 51 systems having a total area of 3,205 ha in dry season only. There are no intake facilities in the area. The bottom elevation of canals is same or lower than the water level of the Mekong river at the beginning of dry season. The farmers use mobile pumps and

traditional lifting for small area in dry season. Poor condition of the road along the Mekong river and too old wooden bridges should be rehabilitated. The farmers are suffering from the high purchase cost of the pump fuel. In comparison with other districts, canal length is rather short, 1.7 km, and covering area of canals is small.

In Prey Veng province, there are 44 colmatage systems having a total area of 2,810 ha in upland crop, 200 ha in wet season paddy and 9,010 ha in dry season paddy. Peam Ro district takes water from the Tonle Toch river and Peam Chor district from the Mekong and the Tonle Toch rivers. Surrounding of the colmatage systems are same as the Leuk Dek District.

In Takeo province, there are 10 colmatage systems having a total area of 24,130 ha in dry season and 700 ha in upland crop. Comparing with the average length of 4.6 km in total, average length in this area is 11.6 km which is quite longer. The farmers use mainly mobile pump and traditional lifting for supplementary recession cropping. The farmers requested to rehabilitate the canals. The width of canals is usually wide and agricultural activity is active. Some canal rehabilitation plan has been commenced by EU.

2.5.4 Institutions and Operation & Maintenance for Irrigation and Drainage System

Organization for construction and rehabilitation of irrigation system is divided into four (4) and shown in Figure 2.13. Present situation of each organization is summarized as below.

(1) Construction Office in GDIMH

GDIMH in central office has a construction office which has the responsibility to implement and repair the major irrigation facilities. There are 300 staff and construction equipment such as truck cranes, bulldozers, excavators, etc. Due to few experienced engineers, old fashioned equipment and lack of funds, it is very difficult to execute the office responsibility.

(2) Provincial GDIMH

The role of the provincial GDIMH offices is to act as an intermediary among the rural communities and the district offices and the central GDIMH. The offices also have the responsibility to rehabilitate and operate and maintain the important large scale irrigation facilities. Staff of provincial GDIMH is 100 persons in average but Kampong Cham office has only 39 staff. Lack of funds, staff's experience, construction equipment, operation and maintenance works for the irrigation facilities is also a problem.

(3) District Office

One of the functions of district office is to operate and maintain the irrigation facilities such as water control facilities, main canals and farm roads, etc. but almost facilities are not operational. Due to lack of transportation, shortage of staff and low salary, it is very difficult for the district office to take care of O&M.

(4) Commune

The commune consists of one (1) to 10 villages and a chief of commune is appointed by the provincial governor. One of the role of commune is the O&M of irrigation systems including

colmatage systems such as dredging the bottom and repairing the slopes of the canals, construction of the flood protection dike crossing the colmatage canal, if necessary, maintenance of the road along the canal and allocation of irrigation water, etc. The chief of commune has to collect the fund from the beneficiaries, because they are imposed a heavy burden to make the dike.

Details for each organization are shown in Appendix D.3.

2.5.5 Farm Road

At present, almost all of the farmers face difficulties in their daily transport for agricultural products as well as social activities on existing farm roads, especially in the rainy season, due to insufficient maintenance of the existing road networks caused by budgetary constrains and lack of farmers organization. The existing farm roads should be at least upgraded to gravel surface.

2.5.6 Security Problem

Existence of anti-personnel mines is the main problem for improvement of agricultural infrastructures and constructions and daily agriculture activities. According to the Cambodia Mine Action Center (CMAC), there are no mines except in north area of Cambodia, but actually, some risks still exist and that has to be eliminated when the development project is implemented.

The security problem remains in a part of Prek Prasap and Chhlong District in Kratie Province, the area along the Mekong river in the south of Ksach Kandal and Lvea Em District in Kandal province and the area around the intersection of the National Road No.6 and No.7 in Kampong Cham province.

2.6 Rural Sociology

2.6.1 Local Administration

Local administration in Cambodia is structured by Province (Khet), District (Srok), Commune (Khum), Village (Phum) and Group (Khrom).

Commune is the lowest unit of public administration. Each unit of local government has an appointed chief of public public administration. The chiefs are paid, except a chief of group, district governor 41,000 riels a month, commune chief 30,000 riels, and village chief 11,000 riels. The province has a system of tax collection i.e. yearly revenue though it is very small compared to its requirements.

The province in the Study Area has 5 to 16 districts. Number of communes and villages under a district varies greatly from 6 to 23 communes, from 19 to 323 villages (see Table 2.11).

A district (Srok) has sections of District, Planning & Statistics, Accounting, Police & Military Police, Agriculture, Education, Public Works, Rural Development, Information, Culture & Art, Transportation & Post, Land, Health & Dispensary, and Business. It has not a district council. The district governor is responsible to convey the national policies to the commune chiefs, to decide a development plan in the district, and to keep security of rural life. The district holds

District Rural Development Committee (DRDC), composed of the governor, his deputy, and chief of sections, though many districts are under a process of forming the committee. The committee meets once a month usually.

A commune (Khum) consist of several to dozen of villages, depending on its population density (see Table 2.11). The commune chief (Mekhum) tries to maintain security in the commune, mediates disputes among villagers which a village chief can not solve, conveys the national policies to village chiefs appointed by district governor. A commune has staff of agriculture, education, and a health center where a medical assistant, a nurse and/or a traditional birth attendant (TBA) work. When there is a public work, the construction materials are provided by the district office. The commune has no council, but the village chiefs meet at the commune office periodically.

A village (Phum) consists of more than 100 households. It is headed by a village chief (Mephum) who is responsible for all the aspects of villagers' life. The village has no office. The villages have started forming Village Development Committee (VDC) to develop the villages by themselves under a guidance of the district rural development sections and/or foreign donors. The committee members are elected under a democratic procedure.

A group (Khrom) is a remnant of Khrom Samaki which practiced a collective farming under the Hen Samrin regime in the early eighties. Khrom is a group of houses whose head is called Group chief (Mekhrom). The Group chief represents the members when required. He is not paid but responsible for the group security. The Group members are often related in a sib, while village members are sometimes related more loosely than the Group.

2.6.2 Rural Society and Social Infrastructure

(1) Rural Socio-economic Survey

A Rural Socio-economic Survey was carried out by JICA Study Team on 1,000 households in the Study Area, 600 farmers along the rivers, 300 farmers away from the rivers, and 100 fishermen. 1,000 villages were selected randomly from the whole districts in the Study Area. One farmer or fisherman was selected from each village. The interviewees were as follows:

Province	Total households	Farmers	Fishermen
Kratie	38 (38)*	34 (34)	4 (4)
Kampong Cham	272 (239)	249 (216)	23 (23)
Prey Veng	289 (79)	258 (70)	31 (9)
Kandal	362 (316)	326 (280)	36 (36)
Takeo	39 (0)	33 (0)	6 (0)
Total	1,000 (672)	900 (600)	100 (72)

* Figures in the brackets show numbers of households interviewed along the rivers.

In order to avoid any bias from interviewers, the visited farmers were always located at the fifth house from an end of a village. The questionnaire covered wide range of questions, totaling 55 items on rural society, household, agriculture, animal, and fishery.

(2) Rural Society

A village is an aggregate of houses which is usually located at a higher place or an artificially mounded area near the road or dike. The residence area is easily found at a far distance where trees are planted intensively, i.e., ever green throughout a year, providing villagers with shade, tranquillity, and fruits. The Cambodian country is characterized with palmyra palm, Borassus flabellifer L.

The paddy fields are separated from the residence, they are far away from the houses. They usually put up a temporary hut by the farm, which is burnt out when a harvest is finished. The long distance from the residence to the field undoubtedly causes inefficient farming. On the other hand, a village aggregated with houses in a place facilitates more intimate social intercourse among villagers, easier communication, and better security against bandits as well.

Life in the flooded areas in wet season changes drastically. Water floods anywhere, it looks like the sea. The main transportation becomes a boat on the water, often without engine. Many farmers go fishing to the water where it was rice fields in dry season.

The rain deteriorates unpaved village roads. People meet difficulty to move on the muddy roads in wet season. Thus a water transportation becomes much easier way. Sometimes the water takes away an access from children going to school. The flood also deteriorates sanitary conditions of the villages. Usually no sewage channels exist in the villages. Most of villages are full of rotten water that causes diarrheal diseases.

A family consists of a little more than 5 members (average 5.4), ranging from 4.1 to 6.2 members according to the demographic data collected from the planning office of Department of Agriculture in the five provinces. But the Rural Socio-economic Survey shows an average of 6.6 members in a family.

Nearly all of rural households use firewood for cooking, a few use charcoal, rice husk, or straw in addition to firewood. Thus, firewood gathering is an important work in the rural areas, firewood are piled for sale at the roadsides, giving villagers a chance to earn non-agricultural income. But it has destroyed the flood forests tremendously.

Source of drinking water is rainfall, rivers, wells and so on. Out of 1,000 households, 475 get water from the rivers, 420 from the rainfall, 335 from the wells, 159 from the tube-wells, and 89 from the ponds and the reservoirs. Only three households buy water from vendors.

More than half of households in the Study Area do not enjoy electricity at all and most of them use oil lamps in stead. Car batteries as an electric source are used in about 20% of the households.

(3) Education

The Rural Socio-economic Survey shows that literacy rate over 16 years old is 83.5% averagely, women 76.3% and men 91.3%. But the Rural Development & Resettlement Project (1994) says that literacy rate over 15 years old is 62.4% averagely, women 43.1% and men 89.6,

attendance rate to schools under 15 years old are 64% averagely, girls 54% and boys 72%, and years in schools are 2.8 years averagely, women 1.9 years and men 4.2 years.

Basic education in Cambodia was 5-3-3 system, 5 years in primary school, 3 years in secondary school and 3 years in high school, but it was improved to 6-3-3 system in September, 1996.

There are 190 primary schools in Kratie province, 656 in Kampong Cham province, 459 in Prey Veng province, 382 in Kandal province and 330 in Takeo province (see Table 2.12). Averagely there exist three to four primary schools in a commune and one primary school in about three villages.

A primary school has 4.3 classrooms averagely in Kratie province, 5.9 in Kampong Cham province, 6.6 in Prey Veng province, 7.5 in Kandal province, 8.5 in Takeo province, and 6.6 rooms averagely in five (5) provinces (see Table 2.12). Provincial Departments of Education needs more classrooms in primary schools, because primary education system requires to add one year and many school buildings have dilapidated. For example, Prey Veng needs 3,768 rooms, Kandal 277 rooms, and Takeo 3,361 rooms.

Number of students in a room varies from 53 to 66 students in primary schools, from 23 to 47 students in secondary schools, and from 28 to 67 students in high schools. A teacher teaches from 43 to 53 students averagely in primary schools. Girls occupy 42.5% to 45.0% in primary schools, 25.5% to 38.6% in secondary schools, and 28.8% to 37.7% in high schools. Drop-out rates show rather small from 1.6% to 3.2% in primary schools, but many repeaters are not in the statistics exists. According to a report in 1994, repetition rates in primary schools are 40% in 1st grade, 29% in 2nd grade, 23% in 3rd grade, 18% in 4th grade, and 18% in 5th grade. It explains that the quality of education should be improved. There is a new movement in primary education system, which is a formation of cluster schools to share scarce resources more effectively, to help isolated schools, and to mobilize community motivation. A cluster has 2 to 10 schools. In Takeo Province, 330 schools are grouped into 52 clusters.

(4) Hospitals

There are one to four provincial hospitals in a province, a district hospital in a district, and one health center in a commune in principle (see Table 2.13). The health center is the first point to reach for rural people. Many health centers at communes are not in good conditions. 44.8% of them need rehabilitation, and 43.9% need new construction. The total number of health centers is reducing because the Provincial Department of Health tries grouping them into referral hospitals to share resources.

Other than those facilities, the departments meet many problems such as low quality of medical staff, deficit of budget, low salary and irregular payment, insufficient equipment and medicines, and scarce office supplies. Serious diseases are tuberculosis, malaria, diarrhea, acute respiratory infection, malnutrition, etc.

(5) Religion

In Cambodia, Buddhism is the largest religion, and fewer people believe in Islam or Christianity. There are 1,629 Buddhist temples in the five provinces, 82 mosques and 21 sub-mosques, 39

churches, 6 Chinese Buddhist temples, and 7 Vietnamese Buddhist temples in the Study Area. There are two to four temples in a commune and a monk to 270 persons (refer to Appendix H).

A temple is a center of mental life in the country. A temple has a sacred pond that only monks can take a bath and people get drinking water from the pond. Primary school is often attached with a temple, because a temple has a temple construction committee, composed of temple caretakers (Achar) from villages. Achar is a selected elder of experiences and Pali knowledge. The committee also takes care of village infrastructures as primary school, village roads, community ponds, etc. Monks and achars, therefore, have influences on village development to some extent.

2.6.3 Public Institutions for Rural Development

For agricultural development, Department of Agronomy or Technique, Economy & Extension is the most important public institutions. As for an irrigation development, GDIMH functions officially for the project implementation.

As for rural development, Ministry of Rural Development, Ministry of Public works, Ministry of Health, Ministry of Education, Ministry of Women's Affairs, and their offices at the provincial and district levels are concerned with the programs. In order to integrate rural development programs, however, Ministry of Rural Development takes initiatives through the development committees at each administrative level.

Cambodian government is now promoting rural development based on the strategy in the First Socio-Economic Development Plan. Setting up of institutional building at the local and governmental levels is recognized as the important aspect for promotion of rural development. It considers people-participatory approach to rural development.

In line with this strategy, a new rural development management structure such as provincial development committee (PDC), district development committee (DDC), commune development committee (CDC) and village development committee (VDC) will be established under the council for agricultural and rural development. The Ministry of Rural Development (MRD) is expected to interact at each level of rural development activity (see Figures 1.12 to 1.15 in Part 2).

Under the overall direction of the PDC, DDC will:

- Prepare plans for their districts for the forthcoming year covering proposed activities and priorities, based on plans submitted by the communes and villages;
- Prepare project proposals at district level which cover more than one commune;
- Provide relevant technical support as needed to the CDCs and VDCs within the district;
- Facilitate flow of information between the PDC and CDCs/VDCs

Meanwhile, VDCs, which will have at least 40% women as members, will be responsible for:

- the identification and analysis of the main problems of their village;
- the prioritization of problems according to importance and urgency;

- the preparation of project proposals and of annual village development plan;
- representing the villagers in putting forward needs and problems to government or other agencies, and seeking out needed technical assistance and training;
- the activation of the village population, assigning of responsibilities for each activity and the mobilization of village resources for plan and project implementation;
- where established, administering the village development fund;
- monitoring and evaluating village-based development activities; and
- The dissemination of information relating to activities and experiences to and from other villages in the area.

VDCs are viewed as the foundation of a bottom-up rural development structure and the basis for achieving participatory and sustainable rural development. VDCs will have an important mechanism for securing the direct involvement of rural households in identifying the most urgent village needs, in project decision making, in operation and maintenance, and in contributing labor or materials for project implementation. Across the country, some 500 VDCs by March 1998 and 7,500 by the end of 2000, which corresponds to 20% and 60% of the total villages, respectively, are targeted to be established.

These offices and committees are potential to lead development programs. The VDC under a process of organization is highly potential because the committee members are elected by villagers through a democratic procedure and it is the place where local population discusses their own needs of development and implementation programs.

The development constraints on these institutions are deficit in the budget, low salaries of the officials, and lack of equipment and office supplies. Another constraint is that many offices at the district level are in the process of institutionalization. Many staff need more trainings on their specialties to upgrade the quality of work. And a coordination with related development programs is very important and its responsibility lies under Ministry of Rural Development at central, provincial and district levels through the development committees.

2.6.4 NGOs in Rural Area

More than 100 international organizations have been working for Cambodia since 1979. They are doing good jobs in various fields where the government's services do not reach. Approach methods of assistance are quite different by organizations. Their budgets are limited and the work is often on a spot in the limited area.

The NGOs have long experiences in Cambodia and get acquainted with people and the custom in Cambodia. Some of NGOs work well in organizing farmers, participatory development, agricultural extension services and training. Recently the number of 83 local NGOs were organized and seventeen of them got set to work in the Study Area, provided that they are supported financially (refer to Appendix H).

2.6.5 Farmers' Organizations

Most of farmers are poor, and they struggle individually to survive in the hardship. They cannot afford to think other things than their own living day by day. Moreover, they have bitter experiences on a group work in the past. Therefore, unless an organization brings a definite benefit to farmers, they seem reluctant to belong to it.

There are some farmers' organizations in the Study Area, but they are groups with a single objective, such as water users' association, rice bank, credit, cow bank, etc. An integrated organization as an agricultural cooperative does not exist. It suggests that a definite organization with a single objective is more realistic at present.

All of the organizations including VDCs were organized under a guidance of the government offices or aid agencies. In the course of organizing, some necessary groups should be led to organize by the relevant government offices, because it is difficult to wait for a spontaneous organization by farmers themselves. A government policy in guideline on irrigation and drainage development denotes that the GDIMH/MAFF has a role to organize and supervise farmer for water user association to manage and operate irrigation system.

In any organizations, the key issue is to find qualified leader elected through a democratic procedure. If the trust is not built, the organization may collapse on the way. In order to keep an organization, some rules or regulations are also necessary. Farmers are needed to be trained on organization until they fully understand the objectives of the organization.

Female headed households are often more disadvantaged in many aspects of rural community. When an organization is established, female headed families should be given equal positions at least to male headed households, or even more favorable considerations should be taken into account because they have been left in the disadvantage for a long time.

2.6.6 Women in Rural Society

The demographic data show that 52.3% of the total population in the Study Area are women, though 51.2% in the Rural Socio-economic Survey. UNICEF describes in 1996 that 53.4% of adults over 18 years old are women. It is shocking that 65% of all people are women particularly between the ages of 35 and 40 (HALCROW, 1994). Thousands of men died in the war and many widows are left to earn day-to-day needs of their families. Many reports describe that approximately one third of families are headed by women in Cambodia at present, but UNICEF says that 20% of households are female headed.

(1) Women in Rural Society

Women are busy. The Rural Socio-economic Survey reveals that they work for 10.14 hours a day averagely. They have to clean the house, wash clothes, fetch water and firewood, cook food, take care of children and work in the paddy fields. And usually a wife keeps money of the family. According to the research on three (3) communities done by Ledgerwood (1992), a wife holds all the money of the family in 92.6% of households.

In the family, however, wife is obedient to husband. Husband attends usually community or village meetings. But wife has no complaints because social matters are in the hands of husband. It is an important aspect in development that women should have more opportunities to speak their needs or ideas in the public.

Marriage is very important for a woman not only personally but also socially and economically. A woman without spouse whether she is widowed, divorced, abandoned or not married, is disadvantaged in all aspects in rural society. She has to do everything to keep her household from cooking to farming practices, though some of the burdens are eased by her children. A female headed household often does not keep cattle to plow the fields nor a person to handle the cattle. Moreover, a female headed household was given smaller piece of land when the land was privatized in 1989 because the female headed family was usually smaller in size than a male headed household (HALCROW, 1994). Usually women are less educated than men and more women remain illiterate than men in Cambodia. It gives further disadvantage to women. Thus, many female headed households are left in destitution.

There is no distinct sexual division in farming practices in Cambodia (Ledgerwood, 1992). Both of sexes do nearly everything needed in the farm except climbing a palm tree done by male. But there are tendencies of the division in several works. Plowing, threshing and caring cattle are done more by male, and pulling seedlings and transplanting are done dominantly by female.

(2) Women's Association

The Revolutionary Women's Association of Kampuchea was formed during the Hen Samrin regime. The association turned its name to the Women's Association of Cambodia in 1989. It was organized at all the levels of administration with several staff hired by the government and played important roles in immunization campaign and helped the poorest women, especially widows, mothers or wives of men in the army, mothers with many young children, and orphans. But, it was dismissed in 1991 because it was considered as a part of a political party, and the staff were shifted into the other governmental offices. After Secretariat of Women's Affairs was established by the government, it becomes to the Ministry of Women's affairs.

The Ministry emphasizes importance of strengthening women in rural areas through trainings on women in occupation, women in family, women in communication, and gender issues. The Ministry already set up offices of Women's Affairs at the provincial level. The district level are still on the way of establishment. Though women's association changed its name and organization, it has been the only organization to work for women.

A staff of Kandal Women's Affairs picked up three issues of non-professionalism, no capital, and low education.

2.6.7 Rural Communication

The communication system is poor in rural areas. There are post offices in the capital of provinces, but they are not used frequently. Telephone communication is not possible except Thakhmau within the reach of Phnom Penh.

2.7 Rural Infrastructures

2.7.1 General

In the course of achieving the agricultural and rural development, improvement of infrastructures especially rural roads and village water supply systems is the key factor. The rural infrastructures have been deteriorated due to the prolonged civil war and lack of securing manpower, equipment, materials and budget for the maintenance. Improvement of rural roads and installation of wells are indispensable for not only transportation of farm products and daily activities but also supply of drinking water in villages.

2.7.2 Rural Road Networks

(1) Institutions Involved in Rural Road Networks

The rural road is operated and managed by the Ministry of Public Works and Transport (MPWT) based on the article 'IV. Access or Local Roads (tertiary - district)' of the 'Road Basic Design Criteria' enacted by the Public Works Research Center. The rural roads had been maintained by the provincial Public Works and Transportation Office. However, according to the interviews with MPWT and the Ministry of Rural Development (MRD), the tasks for construction and maintenance are being transferred to the Department of Community Development, General Department for Technical Affairs, MRD.

(2) Transportation Systems

Farmers has various means for transportation of farm products, such as human labor, ox, ox-cart, motorcycle, and motorcycle drawn cart. Most of farmers depend on ox and ox-cart from fields to their farm yards. The transportation to market is usually conducted by motorcycle or bicycle. But road condition is generally poor.

(3) Present Condition

Total length of roads provided so far is shown as below. National and provincial roads are generally under good condition even in wet season due to asphalt pavement. But most of district and farm roads are poor, no pavement, which are unfunctional during flooding season.

Length of Roads in the Study Area

(km)

Province	National Road	Provincial Road	Rural road	Total
Kampong Cham	167.5	243.4	2,369.5	2,780.4
Kandal	246.0	81.1	1,674.5	2,001.6
Prey Veng	107.1	448.0	1,479.0	2,034.1
Takeo	140.5	121.9	590.0	852.4
Total	661.1	894.4	6,113.0	7,668.5

Source : Public Works and Transportation Service Office in each Province except Kratie.
As for Kratie province, no available data has been collected.

According to the data from Public Works and Transport Service Offices in each province, the average road density in the Study Area is estimated at 0.35 km/m^2, Takeo province is the lowest

density of 0.21 km/m^2, Kandal province is the highest, 0.47 km/m^2, in Kampong Cham and Prey Veng provinces, it is 0.35 km/m^2 and 0.34 km/ m^2 respectively. These figures are nearly average in the Study Area.

Density of Roads in the Study Area

(unit ; km/km^2)

Province	National Road	Provincial Road	Rural road	Total
Kampong Cham	0.025	0.036	0.354	0.415
Kandal	0.069	0.023	0.471	0.563
Prey Veng	0.025	0.104	0.343	0.471
Takeo	0.051	0.044	0.213	0.308
Whole Area	0.038	0.052	0.353	0.442

Source : Public Works and Transportation Service Office in each Province

The road conditions is poor due to insufficient pavement and drainage facilities. The roads become muddy in the rainy season and it is difficult to access to the farms.

2.7.3 Rural Water Supply

(1) Institutions Involved in Rural Water Supply

In the 1980's, rural water supply was operated by the Ministry of Health (MOH) and UNICEF. Since December in 1994, the operating body was removed to Department of Rural Water Supply, General Department for Technical Affairs, MRD. The Oxfam, one of NGOs, also promoted the rural water supply projects in close cooperation with the Ministry of Agriculture's Department of Hydrology (DOH) since 1989, which is proceeded to the PRASAC project under cooperation with Provincial Office of Irrigation, Meteorology and Hydrology at present.

(2) Present Condition

Rural people have traditionally little use of groundwater, tending to rely on pond/river, dug-well and stream in the dry season, and rainwater, pond/river and shallow well in the rainy season. Groundwater from deep well is rather unpopular for drinking, because its taste is 'flat' and it sometimes contains high concentrations of mineral salts or iron, which also give an unpleasant taste.

Since 1980's, construction works of tube-well have been conducted by the above mentioned institutions involving in NGOs. The numbers of drilling well constructed by UNICEF are as follows;

Numbers of Drilling Well Constructed by UNICEF

Provincial Name	Numbers of Well (Nos.)	Density (person/well)	Depth of Well (m)	Water Level (m)	Yield (m^3/hr)
Kratie	15	2,949	37.9	12.2	1.20
Kampong Cham	922	1,279	27.7	9.2	2.56
Kandal	1,483	586	31.2	5.9	3.57
Prey Veng	764	1,009	35.6	5.5	2.97
Takeo	961	548	29.5	5.5	2.36
Total	4,145	818	32.4	7.6	2.53

Source ; Department of Rural Water Supply, MRD

(3) Results of Rural Socio-economic Survey

According to the survey, drinking water sources are mainly pond, river, dug or tube-wells and rainfall. The number of pond or river is almost same as that of dug or tube-wells. Utilizing ratio between surface water (pond/river) and groundwater (dug or tube-wells) is different in each province. Kandal province is depending on pond/river, occupying the highest ratio of 75%, since the access to surface water is much better than groundwater source due to the presence of the Mekong and Bassac rivers. In the province, the ratio of pond/river and dug-wells are 53% and 42% respectively. The ratio of tube-well is few. In Kampong Cham province, dug-well is used, 56%. Pond/river and tube-well are 39% and 5% use respectively. In Prey Veng province, the ratio of three water sources of dug-well, tube-well and pond/river are almost equal. Takeo province has the highest ratio of tube-well, 38% as compared with the other provinces. However, pond/river is the most useful of 53% and dug-well is used 10%. Rainfall is also important source, accounted for 420 households or 42% of total. Detail is shown as below.

The Ratio of Rainfall for Drinking Water Source

Description	Kratie	Kampong Cham	Prey Veng	Kandal	Takeo	Total
Rainfall User	14	130	74	185	17	420
Nos. of Survey	38	272	289	362	39	1,000
Proportion (%)	37	48	26	51	44	42

According to the field survey, almost all of the dug-wells do not have satisfactory yields in the dry season. Though the maintenance of the tube-well facility should be conducted by village people, it is difficult due to technical and financial limitation to maintain pump facilities.

2.8 Fisheries

2.8.1 Freshwater Fish Capture in the Economy

The Cambodian population depends on products from agriculture (mainly rice), livestock, fisheries and forestry for their living. Fish is one of the most important diet throughout the

history. In the old days the people enjoy exploiting fishery resource which seems to be non-exhaustible.

At present the production comes from three sources, inland capture, marine capture and aquaculture, with the current production of about 120,000 ton. Freshwater fish capture predominates with the contribution about 60% (72,000 ton) and least with aquaculture about 7%. The rest is from marine capture. Statistical records in fish production from 1980-1995 (see Table F 1.1.1 in the Appendix F) are found doubtful by many experts as to their reliability since the family fishing product have not been included.

In this Study, therefore, the family fishing product from inland source has been interpolated by conservative estimation from number of existing family fishing gears and their catch per unit of effort. With 66,000 units of family fishing gears and one (1) kg per unit per day, the annual production of 24,000 ton is added. Thus, the production of 96,000 ton is being used to explore their role in the economy.

With the price estimated by the Ministry of Planning in calculation of fishery role in the economy at 0.1016 million Riels/ton, the contribution of fisheries to the GDP is therefore 14.5 billion Riels. With the current GDP (1995) of 324.8 billion Riels, the fishery contribution is thus 4.5% of the GDP.

For contribution of freshwater fish capture in the economy, the discussions will further confine to the roles in fish contribution to GDP, as protein diet or per capita consumption, and employment.

Taking freshwater fish capture in 1995 into consideration, the production of this particular year in the statistical record is 72,500 ton. Together with the readjusted production from family fishing of 24,000 ton, the total freshwater fish catch is therefore 96,500 ton, valued about 9.8 billion Riels. Freshwater fish capture alone contributes about 3% of the GDP. This indicates the importance of freshwater fish capture in the economy.

For general consumption of fishes from every sources, the per capita consumption is estimated to be about 13-15 kg/person/year. In general it is not easy to estimate the per capita fish consumption, particularly with freshwater fishes, since the Cambodians catch and consume fish almost every kind, every size and every where.

However, approximately, with the freshwater fish catch of 96,500 ton and population of 9.7 million the annual per capita consumption can be estimated about 9.95 kg. This is not yet included the per capita consumption from aquaculture of about 1 kg. Comparing with consumption from other protein sources from beef (3.3 kg), pork (8.5 kg) and chicken (2.8 kg), the protein consumption from fishes is much more significant than from the other sources. Moreover it is comparable with the other Southeast Asian countries.

For employment, the definite data also are not readily available. However from the findings of Rural Socio-economic Survey, it is said that about 10% of the population residing near the water bodies fish on full-time basis while the other 90% are involving in fishing at the convenience and need.

Some other estimation also gives a figure that one (1) million rural households are involved in fishing activities, which is inclusive of middle scale and small scale of fisheries and, in many occasions, the laborers in the fishing lots and/or fish processors. This suggests that fishery sector absorbs substantial number of agricultural labor force, particularly in the rural area.

2.8.2 Institutional Framework of Inland Fishery Fields

The institutional framework for inland fishery sector will be described according to their roles involving in fishery planning, control and development. They are Ministry of Planning, Department of Fisheries (DOFi), Education and Training, External Assistance, Institutional credit, Fisheries Law and Fishermen Association.

Ministry of Planning has already established the First Socio-economic Development Plan (1996-2000) of which fishery sub-sector was included. In the planning it is anticipated that the production of 68,000 ton (about 4,500 ton below the present level) from freshwater fish capture, 38,000 ton (about 7,500 ton above the present level) from marine capture and 13,800 ton (about 5,000 ton above the present level) from aquaculture may be achieved in the year 2000. In that composition about 30,000 ton are aimed for export.

To achieve such a target of the DOFi, the only institution who takes role in fishery management, has developed numerous implementation plans or so-called Rehabilitation Project and Fishery Development in five year Plan (see Table F 1.7.1 in the Appendix F). However as weak as it may be, the plan is not objective enough to show the expected results. Furthermore internal arrangement of the DOFi itself is for controlling capture than for other development.

Apart from that the DOFi is also encountering a problem concerning its human resource both in quality and quantity. There is lack of on-the-job training as well as facilities and qualified faculty in the Institutional for education and training, Royal University of Agriculture (RUA) and College of Agriculture (CA), who produce the human resource for the DOFi both in graduate and diploma levels.

The whole country possesses fishery graduate only 8 M.Sc., 153 B.Sc., and 215 Diploma holders which is not sufficient for future fishery development. Taking private sector development in the future which may require very competent scientist and technicians into consideration, human resource problem will be the fundamental problem for time to come (Table F 1.6.1 in the Appendix F).

Fishery sector has been receiving a number of assistance from many agencies, both governmental and non-governmental (details are described in the Appendix F). Due to limitation in financial resources the significant impact in fishery development may be derived from governmental assistance. However the assistance from NGOs may give a good experience for future extension services.

Institutional credit availability is extremely important for fishery development, but it is very scarce. Mostly the fishermen operate either under their own resource or borrow from private sector with very high interest rate and often subject to compulsory sale of their product at a very low price. Without proper remedy this problem will be great obstacle for the industry to develop, particularly in aquaculture.

The fishery law of Cambodia is known as Fiat-Law on Fishery Management and Administration 1987, mostly based on the law prior 1970. The contents are extensive and detailed but there is lacking of consideration on socio-economic implications. By law, all the temporary and permanent water bodies are designated as a fishery domain which is divided into (1) fishery domain assigned by group and (2) fishery domain protected.

The fishery domain assigned by group is furtherly sub-divided into a fishing lots and fish sanctuaries which are in effect by the Ministry's proclamation. Outside the just mentioned area all the inundated areas, both temporary and permanent, belong to fishery domain protected. Total number of 279 fishing lots and 15 fish sanctuaries have already been proclaimed.

To catch fish in a fishing lot one has to be operate only by opened auction which takes place every two year. This is known as industrial fishing which is based on barrage trap and d'ay or set bag, mainly through colmatages and natural canal joining the main rivers, Mekong, Bassac and Tonle Sap, and a backwater lowland. Fishing season is normally opened from October 1st to May 31st.

The purpose of maintaining of fishing lots is mainly for generating the government's revenue. In 1994 total revenue from auction of fishing lots was as much as 4,796.97 million Riels, accounting 67% of the total revenue from fisheries.

Apart from industrial fishing the law also designates the middle scale and family fishing mainly by types of fishing gears (see Table F 1.1.2 in the Appendix F). The fishing gears belonging to the middle scale fishing require permit and limit fishing season meanwhile the family fishing gears require no permit and can be operated all year round, even in the fishing lots during the closed season.

Fishermen association is very useful tool for education of fishery resource management and effective credit operation. However there is no such an organization in freshwater fisheries in Cambodia.

2.8.3 Species Exploited and Pattern

For economic reason the Cambodians divide fishes into three grades, depending upon the species, freshness and sizes. The first grade and second grade refer to a groups of species comprising in a commercial large size fishes, normally one (1) kg up for the first grade and 0.5-1.0 kg for the second grade with exception of some preferable species. The third grade fishes refer to those small fishes of all species that can be used for human consumption but mainly for fish feed and processing, particularly into fish paste, pra hoc, fish sauce and/or dried, ferment and smoked.

Even though fish species composition in Cambodia has been reported to be more than 300 species the frequent observations in the fish markets in Phnom Penh during September and October, 1996, suggest that the predominant commercial species are only about 25 species (see Table F 1.4.1 in the Appendix F), both from capture and culture. The rest may be belonging to the third grade fishes which are not popular in the market.

2.8.4 Mekong Flood Regime and Inland Fisheries

The routes of water flow to and from the lowland are through the colmatages canal, natural river, and the natural low levees. Many of them exist along the Mekong, Bassac and Tonle Sap rivers. Apart from carrying nourish silt, they also carry substantial amount of fishes of various kinds and sizes to the Cambodian people.

Flood depths ranges from few ten centimeters to more than three meters and its duration ranges from few months to more than seven months (see Figure F 2.1.1 in the Appendix F). Some part becomes permanent water bodies or known as a swamp or some permanent wetland, depending upon a depth of remaining water during the dry season.

The fishery ecological importance of flood plain is that the fishes have developed themselves to survive and flourish along with the flood regime. Fishes in Cambodia are able to survive well in a running or standing water regardless whether they are lacustrine or riverine species. The difference mostly lie on the spawning behaviors. Some fishes such as barb and carp require running water to spawn while the others such as snake-head and gourmi require still water to spawn.

Despite different spawning behaviors there is one common to all fishes that they spawn in early rainy season and both young and adult spend one part of their lives in the flood plain area. After a certain period of time, till the end of flood season, they start to migrate along with the receding current to their preferable habitats such as lakes, reservoir, rivers and delta to complete their life cycle. Their diversity and abundance are chiefly depending on the maximum flood levels. Normally the impact will be addressed one year later. This life pattern repeats itself for every flood season to come (see Figure F 1.3.1 in the Appendix F).

Fish capture in Cambodia has been designed to exploit this fish pattern. Based on trial and error fishing gears have been developed to its maximum efficiency and suitable for catching fishes from every parts of the plain.

2.8.5 Freshwater Fish Production

Freshwater fish production in Cambodia comes from two activities, capture and culture. Data from DOFi, even though considered as under recorded, can be used for indicating a trend of exploitation and have shown that total freshwater fish catch started to rise sharply from 18,400 ton (1980) to 50,780 ton (1981) and 64,181 ton (1986). From 1990 to 1995 the catch varied between 65,000 ton (1994) to 74,700 (1991). This suggests that during the last 5 years fish catch has remained rather constant (see Table F 1.1.1 in the Appendix F).

After correlating the fishing efforts, i.e. increment of fishing gears and fish catch, it is obvious that two main fishing gears, barrage trap and effective mobile fishing gears, played a major role in increasing fish production. Despite the tremendous increment of effort from other gears in the later years the catch has still remained rather constant. This suggests that exploitation of fishery resource have reached its maximum yield (see Figure F 1.4.1 in the Appendix F).

Aquaculture production has been recorded since the year 1984 of which 1,610 ton was produced. The industry was developed slowly until 1995 when the production reached only 8,778 ton.

The cage/pen culture, developed from the time when catch surplus that require stocking of live fishes either for marketing or price speculation, predominated with its contribution of about 68% of total aquacultural production. Two main types of carnivorous and high market value fishes, *Channa* and *Pangasius*, have been cultivated. The drawback of this activity is that it is produced at the expense of the third grade fishes about 6 - 10 times by fresh weight, otherwise it can be converted for direct human consumption which can contribute a few kilograms more to per capita fish consumption.

Pond culture is, among all aquaculture activities, the least developed. This is due to lack of many supporting facilities. The low input pond culture and rice cum fish culture which have been proven to improve the socio-economic conditions of the grass root of many countries in Asia, are found to be very low prevalence in Cambodia.

2.8.6 Relation with Farming and Fishing Activities

It is not easy to separate fishermen and farmers in Cambodia since most of the population residing near the water bodies fish either part time or full-time depending upon opportunity availability and need. Since the rural Cambodian people take refuge on agricultural and fishery production, and firewood collection, one or more of their people member may be engaged in one or many types of these activities to survive.

From field reconnaissance, most of the small and middle scale fishermen's response indicated no problems with the farmers. This suggests that they coexist very well with the farmers. However the conflicts between the fishermen and the farmers or among the fishermen themselves are existing in fishing lots due to unequal accessibility to resources, namely, land, water, fish and wood.

The lot licensees want to drain water for catching fish while the farmers want to retain the water for recession cropping. The lot licensees want to preserve an inundated forest in the lots for fish shelter while the farmers want to cut down the tree for firewood and clearing land for cropping. The family fishermen encroach the lots during opened season to catch fish for subsistence while the lot licensees want to benefit from all fishes (Figure F 1.7.2 in the Appendix F shows a typical scheme of conflicts).

2.8.7 Freshwater Fisheries in the Study Area

Seventy-two fishing lots and one fish sanctuary have already been proclaimed in the area covering 450,356 ha. The largest area is in the Province of Kandal (178,907 ha) while the smallest is in the Province of Takeo (46,318 ha) (see Figure 2.14).

Fish production from capture by average is 18.8 kg/ha which varies from 4.6 kg/ha to 66.9 kg/ha depending upon the locations not the sizes of the lots. Fishes of the first grade is on the steady decline from 3,378 ton in 1991 to 1,841 ton in 1995 as well as fishes of the second grade, from 4,781 ton (1992) to 4,027 ton (1995). The third grade fishes catch has however been increased from 17,413 ton to 19,422 ton during the same period. This indicates that exploitation of small sized fishes has been more intensively since fishes of large size become more and more scarce.

Aquaculture in the Study Area is quite stagnant with production from 1,500 ton (1990) to 1,586 ton (1994) or only 86 ton was increased during this last five years, which exhibits very slow increment. Again the cage/pen culture predominated in the activity. Low input pond culture is rarely existing.

2.9 Regional Agricultural Characteristics

2.9.1 Major Natural and Agro-Economic Characteristics

Based on the agro-economic and natural conditions in the Study Area, provincial and district's agricultural characteristics are summarized as follows.

(1) Land Use

Land use is varied depending on water availability, particularly in dry season, and location of the provinces. As shown below, Prey Veng and Takeo are characterized as paddy producing provinces. Wet season paddy predominates in the four (4) provinces excluding Kandal.

Province	Crop Composition		Paddy	
	Paddy	Other Crops	Wet Paddy	Dry Paddy
Kratie	84.7%	15.3%	79.6%	20.4%
Kampong Cham	78.6	21.4	87.6	12.4
Kandal	67.2	32.8	46.9	53.1
Prey Veng	95.9	4.1	80.1	19.9
Takeo	97.9	2.1	77.1	22.9

(2) Paddy Yield

There are considerable differences in paddy yield among the five (5) provinces as shown below:

Province	Yield (kg/ha)		
	Wet	Dry	Average
Kratie	1,478	2,080	1,601
Kampong Cham	1,630	2,508	1,739
Kandal	2,283	3,770	2,969
Prey Veng	1,676	3,717	2,082
Takeo	1,687	3,000	1,988

As far as average yield of paddy, Kandal province is placed on the top in the Study Area and district of Leuk Dek, Kean Svay, Kho Thom and Lvea Em shows higher yield even in Kandal province.

(3) Farm Household Incomes

There are income disparity even in the Study Area. In regard to the total farm household income Kandal province is the highest earning 1.36 million Riels per year per family.

However, family incomes surveyed in the Rural Socio-economic Survey were lower than the poverty line of 2.23 million Riels/year per family excluding one district in Kandal province. Farmers in the three (3) provinces of Kampong Cham, Kandal and Prey Veng have off-farm incomes to supplement family income.

(4) Irrigable Areas

Irrigable areas are composed of two (2) systems, that is, existing lowland irrigation systems and Colmatage systems. In this regard, Kandal is blessed much more irrigable area than the other four (4) provinces.

Province	Annual Irrigable Area (ha)	% to Cultivable Area
Kratie	1,676	8.1
Kampong Cham	26,218	7.7
Kandal	30,150	21.1
Prey Veng	18,420	6.6
Takeo	17,060	9.9

(5) Flooding Areas

Inundation areas with water depth of more than 30 cm during wet season in the Study Area was accounted at 53.3% (633,140 ha) based on the result of the remote sensing survey.

Province	Inundation Areas (%)
Kratie	61.1
Kampong Cham	56.9
Kandal	66.7
Prey Veng	40.4
Takeo	34.4

2.9.2 Agricultural Activities of Province and Districts

Agricultural characteristics of provinces and districts were compiled by taking account of the following indicators; crop diversification, self-sufficiency of paddy, population density, farm income per hectare, agricultural income ratio to living expenditures, averaged paddy yield, ratio of inundation areas, gross crop production value (GCPV) per hectare, and colmatage areas from the agro-economic point of view (see Table 2.14 and Figure 2.15). As a result, Kandal province ultimately shows the highest agro-economic capability in the Study Area, especially the districts along the Bassac and Mekong rivers also evaluated as higher agricultural activity areas or development potentiality area (refer to Appendix I).

2.10 Environment

2.10.1 Environmental Conservation in Flood Plain

The Mekong river provides a broad range of benefits at the national and the community levels. The river is habitants of a variety of fish to exploit rich nutrient sources found in rivers, lakes and marshes. It also supports domestic water and irrigation water supplies, and contributes an important transport medium. River basins frequently perform important flood control and flow regulation functions. The main threats to river basins are over siltation, water pollution, water impoundment, over exploitation of fish, and clearing of riverine and flood plain vegetation.

Rainfed lowland rice is concentrated on the flood plains surrounding the Mekong and the Bassac rivers. Agricultural output is significantly influenced by the weather, in particular by the impact of drought and floods. Areas which can be irrigated in dry season are limited, and supplementary irrigation of wet season crops has to involve diversion and/or water retention structures.

Increasing food demand with population growth, particularly in urban areas and suburbs, has led to intensive farming, which has stimulated farmers to use fertilizers and pesticides indiscriminately. This study shows a trend that many farmers have applied fertilizers and pesticides, particularly for dry season rice in Takeo, Kandal and Prey Veng. The MAFF has been under drafting regulations and guidelines on the application of fertilizer and pesticide.

Cattle is recognized that they significantly contribute to rural development with providing draught power and manure. However, the production efficiency of the livestock is low due to a lack of effective supporting systems for disease control and poorly developed infrastructure for the supply of feed and other necessaries.

Next to rice, fish is the most important diet in Cambodia. The inland capture fisheries are controlled completely by the annual hydrological event of the Mekong river. The event is reflected in a biological cycle of fish migration and reproduction. Valuable species are becoming less abundant and small fish grade is forming a great majority of catch. This change could be the result of more intensive fisheries.

Firewood is still the main source of fuel for domestic cooking and commercial kilns in the Study Area. While many families have to depend mostly for scarce forest and shrubs for their use and sale locally whenever available, rural people can resort to dung sticks, leaf stems, rice husks, and even straw when firewood is expensive and locally scarce.

It is reported that many forests have been lost in Prey Veng, Takeo and Kandal for several decades. Although cultivable lands on flood plains are dominant in the area except Kratie, there are many difficulties for the forest rehabilitation. However, it is clear that unless any actions is taken with recommendation and proposals by UNDP and other assistance agencies, forests will be almost exhausted and the firewood shortage for the population will grow more severe.

Under transition to a market economy, some new factories have been established. There is already concerned over the rapid increase in number of cottage industries in urban and rural

areas with lacking waste management facilities. It is required to prepare environmental regulations, guidelines and standards for setting of technology and environmental practices of industries.

2.10.2 Environmental Conservation Area

The Royal Government expressed a wish to join the Ramsar Convention in 1994. Field and aerial surveys to identify the sites of international importance for listing under the Convention were undertaken by the Ministry of Environment together with the Asian Wetland Bureau in April 1994 in the major wetland areas in Cambodia. As the result, three sites were recommended for the Ramsar list, namely, Boeng Chhma and associated river system and floodplain, Koah Kapik and associated islets, and Middle stretches of Mekong river north of Stung Treng. Bassac Marshes was recommended to be considered for further investigation to list in the future include.

In March 1996, the Ministry of Environment prepared the wetland summary sheet on the Bassac Marshes to recommend for conservation as National Park or Reserve and for field survey on the waterbird inventory on account of high potentiality in biodiversity protected.

This area is formed a fluvial lowland with natural levees, broad flood plains and extensive backswamps. A network of streams involving lakes and swamps traverses from the north to the south through the middle area.

Rice fields are distributed along the sides of the river and the fringe of swamps. The intensive farming system is practiced on river banks and natural levees, where are primarily devoted to vegetable and fruit trees and in the lower area to maize, sesame and legumes.

This area has nine (9) fishing lots, where are accounted for 43% of whole Kandal province fishing lots area. The fisheries production in Kandal is counted for about 20% of Cambodian inland capture fisheries annually.

2.10.3 Flora and Fauna

Forests in Cambodia are the most dominant vegetation covering 62% of total land, and support several species of flora and fauna including 212 species of mammals, 720 bird species, 240 reptile species and more than 2300 species of vascular plants. About 850 species of fish have been recorded in the Great lake and the lower Mekong river.

The limited available data suggest that Cambodia is biologically rich and diverse and harbors several species of fauna of global conservation significance listed in the Red Data Book of International Union for the Conservation of Nature and Natural Resources (refer to Appendix B).

2.10.4 Institutional Framework for Environmental Conservation

The Government has already undertaken significant actions, such as the zoning of 18% in the country into 23 protected areas, the establishment of the State Secretariat for Environment in 1993, now the Ministry of Environment (MOE), and the drafting of the Law on Environmental Protection and Natural Resource Management and relative Degrees. MOE has been given a

broad mandate to protect natural resources and to prevent environmental degradation. The strategy is based on the execution of responsibilities in cooperation with Ministries concerned with specific aspects of natural resources and infrastructure management. MOE has been promoting for strengthening linkages between central MOE and provincial MOE offices and line agencies.

Though still in formative stage, the functions of MOE are evolving to include the management of the national system of protected areas, pollution control, a central role in environmental impact assessment (EIA), environmental evaluation, monitoring and analysis of human activity and natural system and environmental education and communications.

Since the establishment, the Ministry of Environment has had a number of issues in carrying out its basic functions. These are to promote drafting of laws, decrees and regulations for natural resource management, to develop and prepare guidelines and standards for evaluation on planning and implementation of projects, to strengthen government capability in skills and institutional capacity at the central and provincial levels, and to provide budgets for implementation of environmental conservation activities.

2.10.5 Policy and Guideline for Environmental Impact Assessment (EIA)

The Royal Government has yet to establish an institutional and legal framework for EIA.

External supporting agencies have been assisting MOE in the preparation of necessary procedures and legal framework for EIA. An Environmental Assessment Degree Draft has been under review by the Government. International Development Research Center with support from Asian Development Bank is providing technical assistance in the preparation of EIA training, institutional strengthening and capacity building, for the Department of Environmental Impact Assessment.

EIA was originally conceived for evaluating infrastructure projects such as ports, industrial complexes, and dams/reservoirs. Experience has shown that the various types or scale of plans, programs and projects require different levels of environmental documentation. One approach is to phase EIA requirements where an initial environmental evaluation (IEE) is conducted at the early stages of every plans, programs or projects. If there is a justification that the development activity would cause insignificant impacts, or sufficient information to include adequate mitigation actions in the IEE, there may be no reason to prepare additional environmental documentation.

2.11 Recent Related Projects

2.11.1 Agricultural Development Projects

(1) Improvement and Development of Systems along the Mekong Kandal

The project was requested as a grant aid program to Japanese Government in May, 1994. The project area is located between the Mekong and the Bassac rivers, about 10 to 70 km south west of Phnom Penh. The project mainly consist of the rehabilitation of the regulating facilities, desalting and treatment of slope in colmatage canal, raising up of low embankment dike and

providing new mobile pumps and motor pool. By these improvement and development modernizing the colmatage systems, potential crop production including fisheries could be raised.

(2) Programme de Réhabilitation et d'Appui au Secteur Agricole du Cambodge (PRASAC)

The Programme, funded by the European Communities, consists of 1) to improve the domestic water supply, 2) to increase agricultural productivity through irrigation and other pilot projects and 3) to improve access to credit and to increase the number of micro enterprises. The Project area is in the six provinces of Kompong Cham, Kompong Chhnang, Takeo, Kompong Speu, Prey Veng and Svay Rieng.

2.11.2 Rural Development Projects

(1) Rural Development & Resettlement Plan

The project was formed by Japan, Indonesia, Malaysia, Philippine and Thailand through UNHCR. In order to encourage the returnees from the closed refugee camp to resettle in the villages and to improve the livings of rural people, the project was set forth with improving rural infrastructure and constructing four development centers until 1994.

(2) Development Plan for Tonle Sap and Chakdomuk

The Project has been executed by the French Institute for Scientific Research and Cooperation for Development (BCEOM & ORSTOM) since March 1993. The project area covers the Great Lake, it's surrounding area and the Tonle Sap river including the confluence with the Mekong at Chakdomuk. The area has high development potentiality, especially fisheries, agriculture and navigation. The study objectives are to propose specific actions for preserving the environment, to select priority project for development of the area and to implement priority projects.

(3) Management of Freshwater Capture Fisheries in Cambodia

The Project is executed by the Department of Fisheries (DOFi), Mekong River Commission and DANIDA (Denmark) from April 1994 to March 1997, funded by DANIDA. Technical assistance has been carried out on related specialists, studies, training, scholarships, transport equipment, sampling and data analysis and operation cost.

(4) Natural Resources Based Development Strategy for the Tonle Sap Area

Based on the report of "Development Plan for Tonle Sap and Chakdomuk", this project is started in September, 1996.

(5) NGOs

Many NGOs are engaging in the five provinces of the Study Area. In Kratie and Kampong Cham, they take part mainly in the field of education, health and water supply. In Prey Veng, some NGOs assist in agriculture, community development, education, health and water supply.

In Kandal, 10 NGOs among 27 assist in health, 6 in community development, 5 in education and 4 in agriculture. In Takeo, 10 NOGs assist in agriculture, 7 in education and 5 in health.

(6) Rehabilitation Project of National Road No.1

The rehabilitation project was planned by ADB (October 1996). Related to the colmatage improvement project as mentioned 2.11.1 (1), demarcation of implementing works will be required at the crossing sections between road and canal.

2.11.3 Others

(1) Aerial Photography in Cambodia
Aerial Photography: funded by Belgium, EU, Finland and UNDP from 1992 to 1993
Updating the Hydrographic Atlas: funded by Finland from 1988 to 1995

(2) Establishment of a Forestry Resources Inventory Process in Cambodia (1996)

(3) Reconnaissance Survey Project for the Establishment of an Emergency Rehabilitation and Reconstruction Project (1996 by Japan)

(4) Rehabilitation and Development of the Hydro-Meteorological Network in Cambodia (1991 by the Mekong Secretariat)